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ELECTRO-THERAPEUTICS,

MEDICAL AND SURGICAL:

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A HAND-BOOK FOR PHYSICIANS IN THE TREATMENT
OF NERVOUS AND OTHER DISEASES.

THE
PROPERTY
OF THE
N. YORK HOSPITAL.

BY

ALLAN McLANE HAMILTON, M.D.,

PHYSICIAN IN CHARGE OF THE NEW YORK STATE HOSPITAL FOR DISEASES OF THE NERVOUS SYSTEM;
FELLOW OF THE NEW YORK ACADEMY OF MEDICINE; MEMBER OF THE NEW YORK
NEUROLOGICAL, AND COUNTY MEDICAL SOCIETIES, ETC.

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TO

DR. WILLIAM A. HAMMOND,

PHYSICIAN-IN-CHIEF OF THE NEW YORK STATE HOSPITAL FOR DISEASES
OF THE NERVOUS SYSTEM, ETC., ETC.,

THIS WORK

IS DEDICATED AS A PROOF OF THE AUTHOR'S GRATITUDE FOR THE

MANY KINDNESSES OF THE PAST.

PREFACE.

THE need of a simple guide for the general practitioner has prompted the production of the following pages. I have endeavored to make them as practical as possible by avoiding as many of the confusing theories, technical terms, and unproved statements, as I was able. In presenting this little book to the profession, I intend to indorse electricity only as a *very* valuable remedy in certain diseases, not as a specific for every human ill, mental and physical. As a therapeutical means in nearly all forms of Nervous disease, Electricity is invaluable.

I have not mentioned several new modes of application, only because I think they have not been sufficiently or generally tested. My book is the compilation of well-tried measures and reported cases.

I do not enter into the detailed description of the various diseases I allude to, as there are many elaborate and concise works upon this subject, that may be consulted by the reader.

I am indebted to Drs. Frankel, Piffard, Murray, Fisher, Rankin, and others, for their kindness in furnishing me with reports of cases and other data.

ALLAN McLANE HAMILTON.

110 EAST THIRTIETH STREET, *April* 10, 1873.

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ELECTRO-PHYSICS.

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It is unnecessary to follow up the history of electricity; suffice it to say that Thales, many centuries ago, demonstrated the first rudiments of this force, and, since his day, Galvani, Volta, Ampère, Franklin, Faraday, and many others, have groped in the darkness and uncertainty of the subject, and have successively brought new facts to light to astonish the world and advance the knowledge of electric science.

Thales, who lived six centuries before Christ, knew that, when amber was rubbed with silk, it acquired the property of attracting light bodies, but not till several hundred years afterward was it known that other substances possessed a like quality; and these were sulphur, wax, glass, etc. Dr. Gilbert, physician to Queen Elizabeth, was the demonstrator of these facts. In the year 1789 contact electricity was discovered by Galvani, and in the year 1831 induction electricity was given to the world by Faraday.

When a glass rod or stick of sealing-wax is rubbed with a piece of flannel or fur, it will be found to have acquired the power to attract some very light body—for instance, a pith-ball, feather, gold-leaf, or piece of paper—which is repelled afterward. All substances do not, however, receive this electric excitement; some *metals* being occasional exceptions. When a body, electrified, is brought in contact with a new substance, that substance will or will not receive the electricity from the first substance—for instance, when one part of a glass rod is electrified by friction, the extremity of the rod not acted upon will not receive the electricity from the excited part immediately in contact. This property of receiving and conveying electricity we call *conduction*. Bodies are *conductors*, or, *vice versa*, *non-conductors*. But this division is not definite; some bodies will only offer resistance to the passage of the current, and conduct poorly. We call this latter class[1] *semi-conductors*.

Conductors.	*Semi-conductors.*	*Non-conductors.*
Metals.	Alcohol and ether.	Dry oxides.
Well-burnt charcoal.	Powdered glass.	Ice at 25° C.
Graphite.	Flowers of sulphur.	Lime.
Acids.	Dry wood.	Lycopodium.
Aqueous solutions.	Paper.	Caoutchouc.
Water.	Ice at 0°.	Air and dry gases.
Snow.		Dry paper
Vegetables.		Silk.
Animals.		Diamonds and precious stones.
Soluble salts, etc.		Glass.
		Wax.
		Sulphur.
		Resins.
		Amber.
		Shellac.

This list is arranged in the order of decreasing conductivity, or increasing resistance. Certain influences affect conductivity, i. e., heat, cold, and moisture; red-hot glass is a very good conductor, water when frozen is a bad one, etc. Poor conductors are sometimes called *insulators*, that is, they confine electricity to good conductors which they surround.

It is impossible, without going into the subject very deeply, to give a minute description of the phenomena of electricity; for this I refer you to any of the good text-books.

In Electro-therapeutics we make use of two varieties of electricity:

---

[1] Ganot's "Physics," p. 565.

1. Static or frictional electricity.
2. Current electricity.

This latter includes galvanism, and induced, or faradic electricity.

Static electricity is generated by friction, and, whether produced by the cumbrous plate-machine of Holtz, or the simple glass tube and handkerchief, is the same. It has a certain peculiar characteristic, and that is, that it has the power of producing a change in the air, converting the oxygen immediately into *ozone*. Static electricity is analogous to lightning in this respect, and the peculiar change in the atmosphere after a thunder-storm is due to the production of ozone on a larger scale. Static electricity produces but feeble physiological changes. It is only when its tension is very great that any violent effects are shown, and then it may produce even death by the violence of its shock. It has little value in the field of electro-therapeutics. Golding Bird has used it in chorea with success, and others have pronounced it efficacious in amenorrhœa and other female diseases.

When applied to the skin, it produces a peculiar prickling sensation, accompanied by slight redness of the cuticle, and by hyperæsthesia. It does not penetrate beyond the superficial muscles, and even the contractions it produces in them are very weak.

The effects of static electricity may be condensed, however, by collecting it in a Leyden jar. The sensation communicated to a nerve or muscle is intense. A numbness in one end, and a violent contraction in the other, are experienced. Small animals are easily killed by a moderate charge. The Leyden jar is clearly indicated when an irritant is wanted for the superficial tissues; it is not safe to use it, however, when deeper action is desired.[1]

CURRENT ELECTRICITY.

This form of electricity is also known as *dynamic*, or *contact*, and is by far the most important variety.

If two unlike conductors are brought together, either solids and fluids, or metals and gases or fluids, an electric current will be generated. The current produced by gases is very weak, but when two metals, an electro-negative and electro-positive, are brought together in an exciting solution, the current is more powerful. The more remote from each other the bodies stand in the scale, the more active will be the production of the electric fluid. The following table gives the electro-negative and electro-positive elements in their proper order :

---

[1] Meyer's "Medical Electricity."

+[1]
Zinc.
Lead.
Tin.
Iron.
Antimony.
Copper.
Silver.
Gold.
Platinum.
Carbon.
—[2]

When two of these are placed in contact in acidulated water, the current in the connecting wire proceeds from the one lower in the scale to the one higher, the two extremes giving the most intense results.

The electrical deportment of any metal depends, therefore, on the metal it is associated with. Iron, for instance, is electro-negative toward zinc; copper is electro-negative toward zinc; and iron but electro-positive toward silver.

If the wires connecting the plates of the battery be cut, the terminal ends of each receive the name of *poles.*[3] The current passes from the — to the + under the surface of the solution, and *vice versa* above. When the extremities of the wire are brought together, the point is called the *terminal arch.*

POLARIZATION.—During the action of all batteries there is a process going on known as *polarization*, which presents the following phenomena: When the elements of the battery are immersed in the exciting solution, hydrogen and oxygen are formed by the decomposition of the water. The hydrogen goes to the copper pole at once, and the oxygen to the zinc. There is a local action going on all the time on the surface of the plates; by this small currents are generated between the impurities in the zinc and the zinc itself. As this process continues, the current loses its intensity, and is finally destroyed.

---

[1] + represents the electro-negative sign.

[2] — represents the electro-positive sign.

[3] "Electrode" is also used for the term *pole*, from *ἤλεκτρον* and *ὁδὸς*, way.

Amalgamation of the zinc-element prevents this. Another phenomenon of polarization may be the accumulation of hydrogen at the negative plate, and with this there will be a deposit of zinc, or positive metal, on the copper, or negative plate. In this way a current directly adverse to the original will be produced. This tendency may be overcome by simply breaking the current or wiping the plate.

QUANTITY AND INTENSITY are terms of great importance in the nomenclature of the electric current. *Quantity* signifies an inert volume of electricity; while *tension*, or *intensity*, the energy by which the current is impelled. The origin of this propulsion is due to the number of cups and the strength of the exciting solution. For quantity a large plate-surface is required, while for intensity a great number of small cells generate a current of tension with no more quantity than the first cell furnishes. The tension increases with the number of plates; in the middle the free electricity is inconsiderable, while the poles of the battery are the two opposing halves. The junction of the negative element of one cell to the positive of the other prevents the formation of more than a certain amount of electricity, and the resistance it has the power to overcome in its circuit, in many cells, is just the power in one cell multiplied by the number.

Ohm's law is unintelligible to the ordinary mind almost, on account of its obscurity; but Smee, in his "Elements of Electro-Metallurgy,"[1] has condensed it as follows:

"The action (A) is equal to the electro-motive force (E) multiplied by the number of cells (n), divided by the resistance the current has to overcome, external to the liquid of each battery (R), *plus* the resistance encountered by the peculiar arrangement of each cell (r) multiplied by the number of cells (n).

It would be thus:

$$A = \frac{n E}{n R + r}$$

In this formula, Ohm has discarded the terms quantity and intensity, and unfortunately has adopted the contact instead of the chemical theory of the pile."

---

[1] "Elements of Electro-Metallurgy," p. 11.

All the phenomena of tension may be studied with the *galvanometer*, and this consists of a needle balanced above a coil of insulated wire; when this is connected with the battery, the deflection of the needle indicates the tension of the current.

Galvanic batteries may be *simple* or *compound*. This distinction consists in the fact that a simple battery has one cell (Fig. 1), while a compound battery has a number, the poles of the elements in each being joined alternately (Fig. 2), as I mentioned when I spoke of tension. When the terminal ends of the wires connecting the poles are separated, the circuit is said to be broken. The combination of the various electro-negative and electro-positive metals and the variety of exciting solutions are almost numberless. From the simple voltaic pile, with which most of the earliest experiments were made, to the more complicated apparatus of the present day, the march of improvement has been rapid. The voltaic pile is dismissed almost entirely. Dr. Hammond, of this city, has made an improvement, however, and presents to the profession a most complete and excellent instrument (Fig. 3). It consists of a number of perforated boxes of zinc and copper, between each of which is interposed a piece of felt or cloth moistened by an exciting solution. In Europe the voltaic pile is confined chiefly to the operation of electrolysis by Ciniselli and others.

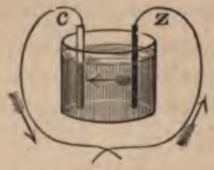


FIG. 1.—Simple Battery.

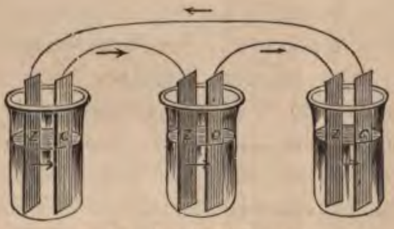


FIG. 2.—Compound Battery.

Undoubtedly the simplest form of cell is that of Smee. (Fig. 4.)

Smee's battery is formed of carbon or silver and unpolished zinc well amalgamated, and needs but one cell and one fluid to excite it. The silver plate is coated with platinum. The zinc and the silver plates are held together by clamps, and the interposition of a bar of hard wood prevents the passages of the current from plate to plate. The exciting solution is water acidulated with one-seventh its bulk of oil of vitriol.

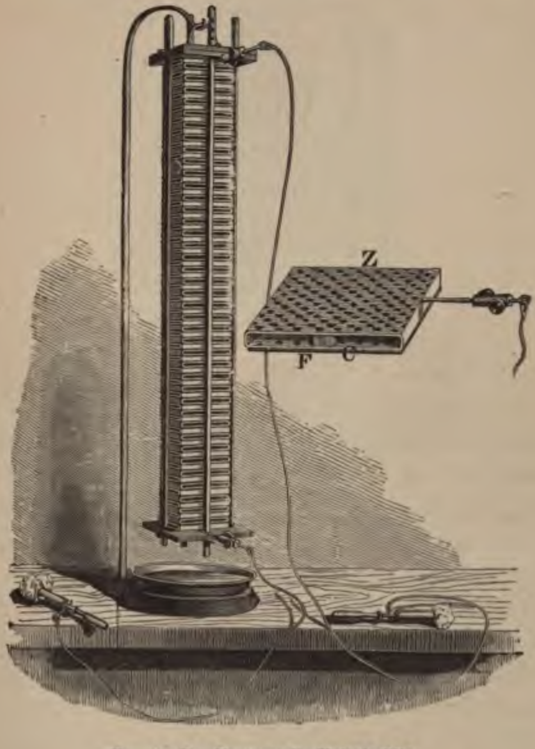
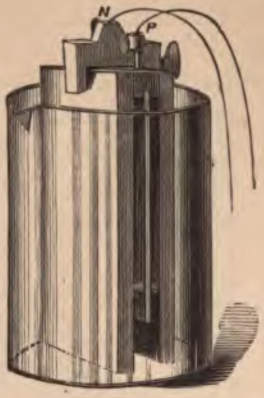


FIG. 3.—Dr. Hammond's Voltaic Pile.

Grove's battery is most powerful; but, as its action is attended with the fumes of hyponitrous acid, it does not rank as high in the list of electro-therapeutical instruments as some others. The negative element is platinum, and the positive zinc. The platinum plate is enclosed in a porous cell filled with nitric acid; the zinc surrounds it, immersed in a dilute solution of sulphuric acid. In the operations of galvanic surgery perhaps it has value.

FIG. 4.



Bunsen's battery is a slight modification of Grove's. In this the platinum plate is substituted by carbon, and a solution of bichromate of potash is used instead of nitric acid.

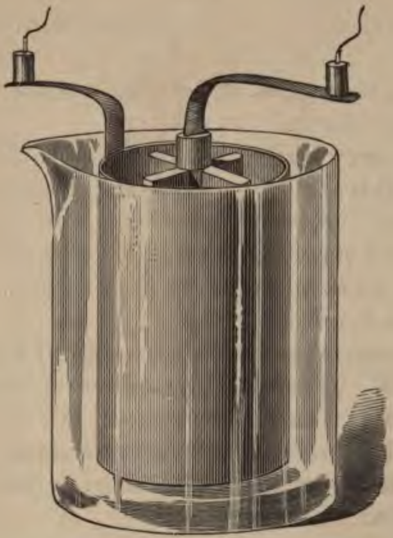
Grenet's battery, described in many foreign text-books, is constructed for the purpose of galvano-causty. The elements and solutions are the same as in the Bunsen. Curt W. Meyer, of this city, has recently invented an improvement on the Smee battery, which is superior to the original (Fig. 5). Platinized lead and a large element of zinc are used, the exciting solution being the same.

Hammond's Battery.[1]—Quite recently Dr. Hammond made a modification of Hill's cell. Each cell contains about half a gallon of fluid. A disk of sheet-copper is laid on the bottom of the cell; an insulated wire connects with this, forming the *positive pole*, the copper being the *negative plate*. About six inches above this a zinc plate is suspended upon a hanger from the edge of the glass. This zinc has a large hole in the centre. A binding screw on the hanger forms the *negative pole*. The body of the fluid consists of a saturated solution of sulphate of zinc. Occasionally crystals of sulphate of copper are dropped through the aperture in the zinc to the bottom of the fluid. We

[1] *New York Medical Journal*, November, 1871, p. 486.

thus have two distinct solutions, which are separate, the denser solution of sulphate of copper remaining below. The two plates are constantly surrounded by different solutions. A sixty-cell battery of this kind has been in use at the New York State Hospital for the Diseases of the Nervous System for nearly a year, and, beyond the occasional supply of a few crys-

FIG. 5.



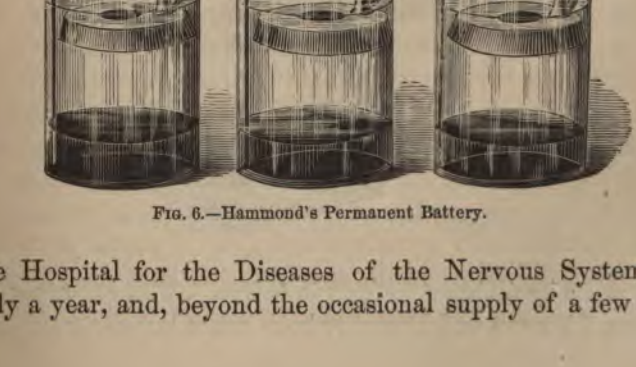


FIG. 6.—Hammond's Permanent Battery.

tals of sulphate of copper, no other trouble has been taken, and its action is now as intense as on the first day of erection.

A film of paraffine poured on the surface of the fluid in each cell prevents evaporation, and does not interfere with chemical action. The Galvano-Faradic Company manufacture this battery, and also a "regulator," combining current-selector, polarity-changers, rheotomes, and a galvanometer, upon the plan of Remak's instrument.

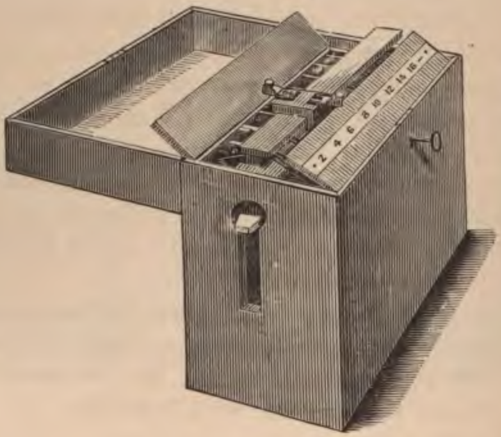
There are many foreign batteries which are no better than those made in this country. These are Middledorp's, Remak's, Fromhold's, and others. Drs. Piffard and Sass, of this city, both use Smee's elements, which they find answer every purpose as well as those of European manufacture. The desideratum in galvanic batteries is—

1. That chemical action and consequent waste of material should be slight. This is overcome by using certain weak solutions, and having an apparatus that can easily be made to remove the elements from the solution after use.

2. The batteries must neither have too great quantity nor too little tension.

The Stöhrer battery combines these requirements, and has been made by different makers in this city, with improvements. Messrs. Tiemann and Drescher both make the Stöhrer battery,

FIG. 7.



and the Galvano-Faradic Company have constructed many which are the best I have seen. I have one in my office which I cannot too highly recommend.

The elements in the Stöhrer battery are carbon and zinc; these are arranged side by side in a glass vessel, with a solution of bichromate of potass, sulphuric acid, and water, as an exciting medium. (*See* Appendix.) From sixteen to thirty-two cells are placed in two parallel rows, two cells connecting on either side. Above and between the two rows runs a long, wooden track, and on this slides a "coupler," to which are affixed two binding posts, from which emerge the positive and negative wires. By sliding this coupler backward or forward, any number of cells can be used, and this is indicated by corresponding numbers engraved on a strip of brass that runs the entire length of the battery. Fig. 8 represents the apparatus made by the Galvano-Faradic Company. Two handles (2.2.) lower the cells, so that, when out of use, the solution is not in contact with the plates.

Curt W. Meyer has made a very beautiful instrument, which he calls the "Universal Platina Zinc Battery." As the name indicates, platina and zinc are the elements. The exciting solution is sulphuric acid (Fig. 9).

Varied devices on top select the current, or number of cups, and also interrupt the current.

Numerous attachments are adjusted to these batteries. The battery of the Galvano-Faradic Company is supplied with a very ingenious current-changer, by which the polarity of the current can be instantly changed. We can get the descending or ascending currents in this manner.

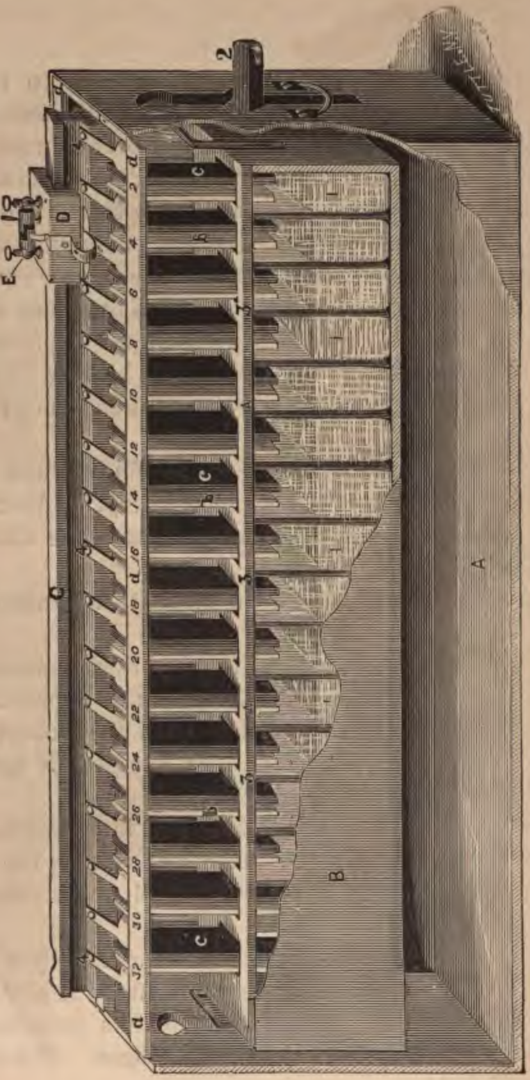
To most of the batteries is attached an interrupter, or rheotome, by which shocks may be made by breaking the current. This is in some done by a toothed wheel, or in others by a pendulum moved by clock-work.

Mr. Curt W. Meyer has just perfected a battery which certainly deserves great praise for its simplicity. A glance at the cut (Fig. 10), and reference to Mr. Meyer's description, will enable the reader to appreciate its advantages. The elements are carbon and zinc:

"The construction of the single cell will be seen in A.

At the bottom of a glass tube, of the dimensions of a test-tube, is a platinum wire melted into it, extending as well inside as outside. The tube is filled one-third of its height with prepared

FIG. 8.



GALVANO-FARADIC COMPANY'S GALVANIC BATTERY.
(Piece cut away, showing cells.)

gas-carbon; above this carbon a saturated solution of water and sal ammonia is poured up to two-thirds the height of the tube, by which means the porous jar, as required in a Leclanche battery, becomes unnecessary. The upper part of the tube is coated on the inside to prevent the solution from adhering to the glass, and so as not to form crystals of sal ammonia, which,

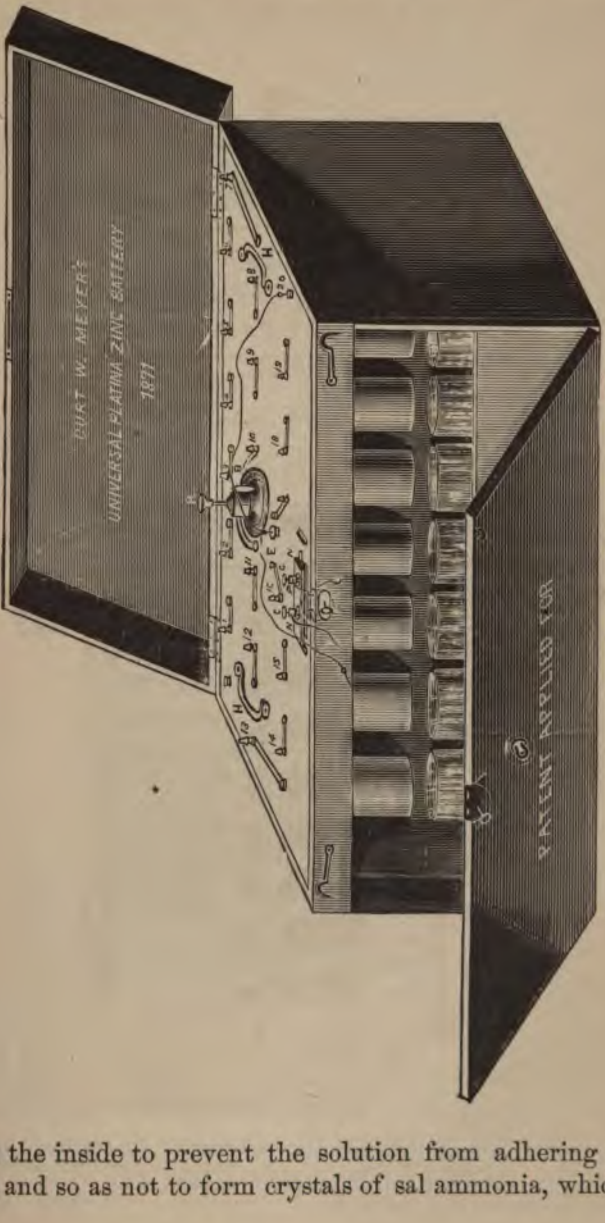


Fig. 9.

by capillary attraction, would further soak up the solution and cause these crystals to rise over the upper edge of the tube. The tube is closed loosely on the top by means of a rubber stopper in which a rod is fastened connecting the zinc, so as not to be moved up or down.

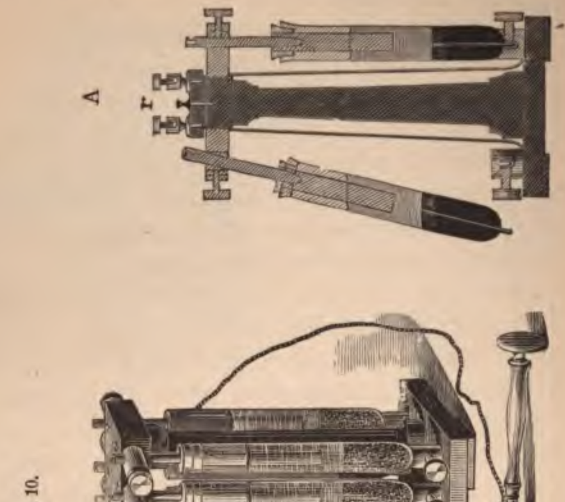


Fig. 10.

"B. The current-selector (*m*) serves to connect any desired number of elements by means of the two cord-pins (*a* and *b*); but only one must remain connected at a time; the second cord-pin only serves to act, when an alteration of the number of elements is required, in which case the connected pin remains connected until the desired new connection is completed by means of the disconnected cord. In this manner any desired connection or any alteration in the number of elements, as well as any desired current-fluctuations, can be produced without causing an entire interruption."

The Galvano-Faradic Company have recently made a most excellent modification of the celebrated Brenner battery, by which the cumbersome table of the original battery is done away with, and a neat glass case substituted. These batteries are furnished with a most complete set of rheostats, galvanometer, current-selector, etc., in a very small space.

Pülvermacher's chain consists of a number of alternate slips of copper and zinc wired together in the form of a chain. When these are immersed in dilute acetic acid, a mild current is generated. These chains have been worn about paralyzed limbs, and the action sometimes has been sufficient to vesicate the part. Numerous disks, "galvanic insoles," etc., have been lauded by different physicians. Garret's disks will be hereafter alluded to.

CHAPTER II.

THE INDUCED CURRENT.

General Laws of the Induced Current.—Theory of Induction.—Rotary and Chemico-Magnetic Batteries.—Induction Apparatus.—Galvano-Faradic Company's Apparatus.—Curt W. Meyer's Apparatus.

THE second division of current electricity is the *induced*, or *faradic* current; but, before we go further, it will be advisable to consider briefly the theory of induction.

It was Faraday who discovered that, at the moment of opening and closing a galvanic circuit, a current was produced in another conductor placed near that of the battery, and that this current ran in the opposite direction to the primary one. This current is but instantaneous, however, and only renewed on the closure or opening of the circuit, to disappear again on the instant, and reappear as often as the connection is made or broken, for, during this interval, or during all the time that the first current flows, the new one does not exist. A current of this kind is called the *induced*, or *secondary* current, in opposition to the inducing, or *primary* one. This current was called by Duchenne *faradism*, in honor of Faraday, its discoverer; whence have come into use the terms faradic or faradaic, and faradization, a term suggested in analogy with galvanization.

In the production of the current by the magneto-electric machine, a bar of soft iron is magnetized and demagnetized, and this induces in a parallel wire a vibratory or to-and-fro current, which is more magnetic than the inducing current.

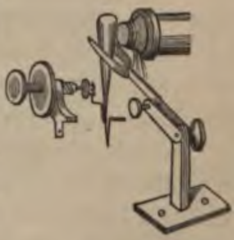
The currents produced by the rotatory machine are broken in the interval between the interruptions, and are barely appreciable on account of their brevity.

The course of the current is an important consideration, and may be learned by holding the conductors, or electrodes, in the hands, when the most pain will be experienced where the current leaves the body—that is, in the hand grasping the negative electrode.

The rotary magnetic machine and chemico-magnetic instrument both produce the same kind of electricity. They both have their champions, but the faradic current is that in general use. The electro-magnetic instrument often needs two persons for its manipulation, while the faradic can be set in motion and stopped without trouble, and the electrodes can be manipulated by one person. The electro-magnetic current is not reliable, varying in strength at different times. The coil of the induction apparatus must be small, and the wire thin and fine. As I have said before, the induction apparatus should have two currents—a *primary* and *secondary*. Duchenne calls them "currents of the first and second order." The *primary* acts more particularly on the muscles, while the *secondary* influences the sentient nerves.

Induction Apparatus.—An induction instrument must consist of a battery, a coil, a centre bundle of wire, or piece of soft iron, and contrivances to break the current. The instruments in most common use are of this variety. Many different kinds are made, most of them wretched affairs, fabricated chiefly for empirics and domestic use. The more brass that attracts the eye, the better. One inventor states in his circular that *his instrument furnishes ten currents!* It is better that Faraday died when he did, than to have lived to see his discovery so improved upon.

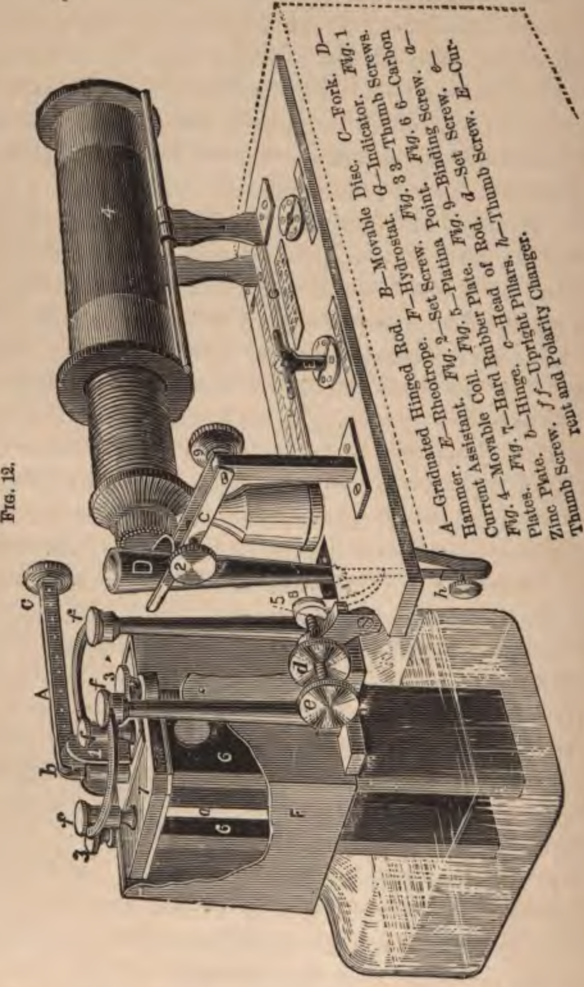
FIG. 11.



Happily we are emerging from this dark age, and the instruments now offered for sale are constructed upon scientific principles. Many makers now turn out really better instruments than those of European make. The instruments made by the Galvano-Faradic Company, of this city, Messrs. Curt Meyer and Drescher, of New York, and Hall, of Boston, are all excellent. I have used the induction apparatus of the first-named company for some time, and am convinced that there are none better made.

Fig. 11 represents a very ingenious attachment made to the Galvano-Faradic Company's batteries. It consists of a fork which regulates the vibrations of the rheotome by which the intervals may be almost imperceptible on account of their brevity, or, contrarywise, the shocks occur very slowly, the intervals being longer.

FIG. 12.



A—Graduated Hinged Rod. B—Movable Disc. C—Fork. D—Hammer. E—Rheotrope. F—Hydrostat. G—Indicator. *Fig.* 1 Current Assistant. *Fig.* 2—Set Screw. *Fig.* 3 3—Thumb Screws. *Fig.* 4—Movable Coil. *Fig.* 5—Platina Point. *Fig.* 6 6—Carbon Plates. *Fig.* 7—Hard Rubber Plate. *Fig.* 9—Binding Screw. *a*—Zinc Plate. *b*—Hinge. *c*—Head of Rod. *d*—Set Screw. *e*—Thumb Screw. *ff*—Upright Pillars. *h*—Thumb Screw. *E*—Current and Polarity Changer.

They are portable, efficient, and never get out of order. Probably every one is familiar with this apparatus. Fig. 12 gives a view of it, with the case removed.

I append the description which Mr. Bartlett has published:

"Letter *A* represents the *graduated hinged rod*, to the lower end of which the zinc plate is attached. The hinge (*b*) enables the rod to be laid on horizontally when the battery is not required for action, thereby preventing the accidental immersion of the zinc plate in the battery fluid. The graduated points on the rod exhibit the depth to which the zinc, when the rod is lowered down, becomes immersed in the fluid, thus indicating the battery-power obtained.

"*The spring* 1 presses against the head (*c*) of the rod when that is fully down in the cell, and thereby becomes impaired if it is not free from acids and untarnished.

"*B* exhibits the *movable disk* which plays against the platina point (5) connecting it with the battery. After continued use, this portion of the disk becomes oxidized by the electric spark. When this happens, the action of the instrument will be irregular. The disk being movable, may be turned a very little around on its pivot, whereby a fresh surface of its periphery will be brought to play against the platina point. The action of the instrument will then be immediately restored. A considerable interval may elapse before this change is required.

"The *adjusting screw* to which the platina point is attached occasionally requires rearrangement. This can be effected by loosening the set screw (*d*); then, turning carefully the end thumb-screw (*e*); when the desired point is obtained, tighten the set screw, and all will be retained in position. The correct adjustment of this screw is essential to the motion of the machine.

"*C*, *adjustable fork*, appertaining to the rheotome. The free end embraces the hammer, or vibrating armature spring or lever (*D*), between its prongs, so as to control the vibrations. When the fork is depressed, the upper end of the hammer can vibrate freely. When it is raised, its prongs will, in proportion to the extent of its elevation, limit the space for the vibrations, and consequently their rapidity will be increased. Thus we are enabled to control at will the interval between each shock, a point of great significance in therapeutics.

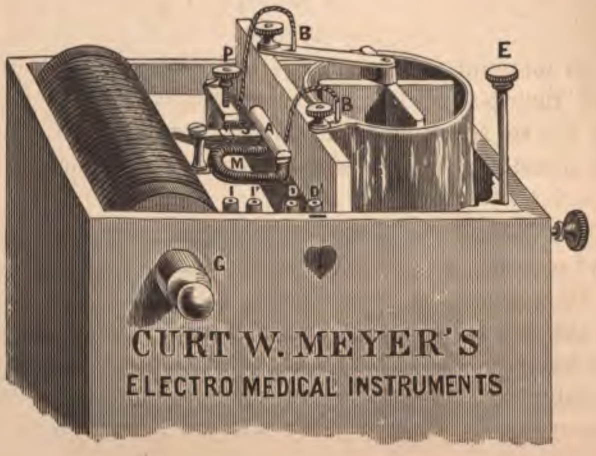
"2 is a set screw placed to work against the fork, and regulate its position laterally in reference to the hammer. When it leans too much on either side, it can be regulated by this screw.

"The hammer may lean over, if its spring should happen to be strained, either toward the magnet or in the opposite direction. This can be instantly remedied by the thumb-screw (*h*), which, on removing the platform and machine from the box, will be found below the spring. Loosening this screw will withdraw the hammer from the magnet; tightening will overcome its outward inclination, so that, in either case, it can be made to resume its perpendicular position.

"*E* the *combined current and polarity changer*.

"*F* represents *Powell's hydrostat*, or capping, broken away to exhibit the interior of the cell, the zinc plate (*a*), and the carbon plates (6 6). Interposed between the hard-rubber plate (7) and the top of the cell is a soft packing. The capping can be pressed down the desired extent by means of the thumb-screws (3 3), thus preventing the spilling or splashing over of the liquid, impeding evaporation, maintaining the strength of the battery fluid, and affixing the cells steadily in their places."

FIG. 13.



The apparatus of Mr. Curt W. Meyer, of New York, has many modifications; probably the best one is represented in Fig. 13. The cell is Mr. Meyer's modification of Smee. In this battery the current is very "smooth," and may be made very powerful, as the coil is large. For those who desire foreign instruments, Stöhrer's induction apparatus is made by Messrs. Tiemann, of this city, or Du Bois-Reymond's, Siemens & Halski's, Ladd's, and Graiffe's, may be imported, but are expensive, and no better than those of American make. For the management of either of these instruments, I refer you to the maker's directions which accompany them.

ELECTRO-PHYSIOLOGY.

CHAPTER III.

PHENOMENA OF THE TWO CURRENTS.

Inherent Electricity of Animal Bodies.—Phenomenon in Nerve-Trunks and Muscles.—Action of Blood upon the Galvanic Needles.—Scoutellen's Theory.—Effects of Electricity upon special parts.—Different effects of the Two Currents.—Different conditions varying the influence.—Action on the Nervous-System.—The Brain, Spinal Cord, etc.—Tongue, Eye, Ear, etc.—Motor Nerves and Muscles.—Electrotonus.—Point of Indifference, etc.—Muscular Contractility and Sensibility.—Upon the Sensor Nerves.—Upon the Sympathetic.—Upon the Blood.—Upon the Organs of Digestion and Secretion.—Upon the Urinary and Sexual Organs.—Upon the Absorbents.—Influence upon the Process of Nutrition.—Upon the Skin.

BEFORE considering the especial effects of electricity as a therapeutical agent upon the human body, we will dwell for a moment upon the consideration of the existence of certain currents which are inherent.

It is hardly necessary to speak of those animals endowed by Nature with electric apparatus of attack and defence. The properties of the gymnotus, or electric eel, the torpedo, or ray, are known to all. Du Bois-Reymond discovered that an electric current exists in the trunks of nerves, and also in muscles, not only in the active but passive states. This current does not pass across the line of the nerve, but takes a course from the centre to the periphery. In the muscles the same phenomena are observed, but the current is much stronger. Every muscle and nerve contains ultimate electric molecules, which are supposed to move in these tissues with great regularity. They are positive and negative.

This current may be demonstrated most clearly in the frog, and M. Nobili[1] performed several interesting experiments with the frog's legs, proving that a current passed from the muscle to the nerve from above downward.

De la Rive, Ahrens, Radcliffe, and others, demonstrated the existence of this current in the living animal in a state of inaction by the galvanoscope; they found also that this free electricity existed in all parts of the body in a *positive* form, and that, when the circulation is excited, the amount of inherent electricity is increased. Freshly-drawn blood (arterial), Shettle says, produces a deflection of the needle of the galvanometer when contact is made by electrodes. Experiments made by M. Scoutellen, of Paris, advance a curious and not improbable theory, viz., that the electric current is generated in the circulatory system—the venous and arterial bloods being different elements (electric), and the walls of the vessels porous cells, that, like batteries, they produce a current. This he verifies by experiments upon horses. He says that there is an appreciable positive current detected by the galvanometer passing from the arterial to the venous blood. All parts of the body, of course, being supplied by the sanguineous fluid, are supplied also by electric stimulation. These electric molecules demonstrated by Du Bois-Reymond are constantly stimulated by the electric fluid, and the different functions of the body are performed. "The oxygen contained in the red blood-globules burns up the organic molecules with which it is in contact, and produces heat." The influence of electricity effects, during digestion, the selection of the nutritive molecules and their assimilation. In respiration, the phenomena are the same. "These facts perfectly agree with the electric phenomena of combustion. The carbon takes the negative electricity, and the surrounding air the positive, or rather the current is established between the carbon and the oxygen of the air. Now, the principal action of the red blood, by reason of the oxygen in it, is the producing of a true combustion in our tissues."

EFFECTS OF ELECTRICITY UPON SPECIAL PARTS.

The wide difference in the effects of the two currents upon the various organs makes it no easy matter to concisely describe the effects of electricity upon the body as a whole. We will find, for instance, that the galvanic current does not affect the muscles exactly as the faradic does; that the effects upon the skin are different; that sensation is excited by one not in the same way that it is by the other. Many influences also govern the effects of these currents: dryness or moisture, a broad surface of metal in the electrode, or a point, and so on. The action of electricity is dependent also upon the condition of the organ it is applied to, the effects being vastly different in one organ from what they are in another.

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[1] "Annales de Chimie et de Phys.," 1828, vol. xxxviii., p. 225.

The time of application is another point. For instance, a current of electricity applied for a short time will stimulate the nerves and excite the circulation; if beyond a reasonable time, paralysis of the nerve will ensue, and ultimately destruction of the tissues beneath.

THE ACTION OF ELECTRICITY UPON THE NERVOUS AND MUSCULAR SYSTEMS.

Upon the Brain.—When the brain is subjected to electrical stimulus, the effect is barely appreciable. The galvanic current produces but slight results. Flashes of light and a metallic taste in the mouth are the evidences shown in those parts receiving their nervous supply from the brain. Continuously applied to the exterior of the cranium, it is supposed to produce dilatation of the vessels in the cerebral substance. M. Erb[1] has demonstrated that the skull does not offer any obstructions to the passage of the current, and Meyer verifies this.[2]

Galvanization of particular parts of the brain will excite contractions of the muscles. Irritation of the corpora quadrigemina produces muscular contractions. Matteucci proved that stimulation of the crura cerebri is also followed by muscular contractions. From the fact that all the symptoms of vertigo, retinal flashes, etc., are produced, we have all reason to suppose that the brain is affected by the electrical current.

Upon the Spinal Cord.—In the vivisected subject, when the current is passed through the cord, violent spasms of the body will follow. In the medulla oblongata the same effects are observed, and are shown in the organs supplied by nerves whose roots of origin are in this part. When external electrization is made by the faradic current, we have like effects, but not so marked. If the spinal cord be cut, and the end of one-half electrized, contractions occur in all the muscles supplied by motor nerves coming from the electrized part. At different points, if stimulation be made, all nerves emerging from these parts, and other nerves inosculating with them, will come under the electrical influence. During the time of application of the continuous current the sensibility of the cord is gone. It may be pricked or injured, without any evidence of disturbed sensation.

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[1] "Deutsches Archiv.," 1867, vol. iii., p. 237.

[2] Meyer's "Medical Electricity," p. 78.

Two portions of the cord notably affected are the *cilio-spinal* (between the seventh cervical and sixth dorsal vertebræ), and the *lumbar* region (at a point corresponding to the fourth lumbar vertebra). At these two points the sympathetic nerve is electrified by the current, producing a dilatation of the iris when the *cilio-spinal* portion is electrified, and a decided contraction of the vas deferens, bladder, and lower part of the rectum, when the current is passed through the lumbar region.

It is doubtful if the electro-magnetic or static currents produce any marked effects upon the cord. M. Erb, however, thinks that the *continuous current* is transmitted through the bony covering of the spinal cord on account of the amount of water it contains, much more easily than through the skull.

The most marked effects of electricity, however, are upon the special organs of sense, and some of the most brilliant successes in electro-therapeutics have been shown in these parts.

The Eye.—If we place one plate of a galvanic element upon the forehead, and another over the infra-orbital nerve, a vivid perception of light is produced. Galvanization of that part of the sympathetic supplying the iris will result in dilatation of the pupil. Direct irritation will result in contraction of the same. The flash of light produced by the electric current will follow the excitation of any part of the fifth pair, and the action is reflex. This Purkinje demonstrated. Other observers, among them Ruete, have proved that the sensation is strongest at the maculæ lutea. The flash is very vivid if the two points of the electrode be placed upon the conjunctiva.

The Auditory Apparatus.—The organ of hearing presents the following phenomena when influenced by the electric currents. The sense of hearing is excited, and all sounds are received more acutely. If the meatus be filled with water, the current is conducted to the muscles of the tympanum, and this tissue is put in a state of tension; consequently sounds have a higher pitch. During this operation the sensorium responds by sounds, not only at the closing, but during the circuit. The tension of the current governs this heightened appreciation of sound. If it be increased, the tension and irritation of the auditory nerves will be painful. The effect will be stronger if the negative pole be applied to the ear (Althaus).[1]

For a concise description of the effects of the currents upon the auditory nerve, I refer you to the observations of Dr. Brenner, of St. Petersburg, quoted by Dr. Althaus in his work.

The Organ of Smell.—An impression upon the olfactory nerve is not produced except by the continuous current, and this effect is followed by giddiness and a peculiar smell. During and after the galvanic influence, it is impossible to sneeze, and an acid odor is perceived. It must not be confounded, however, with the smell of *ozone*, which attends the action of the static instrument.

The Organ of Taste.—Galvanic currents produce upon the tongue twitchings of that organ, a metallic taste, and flashes of light. This experiment may be tried upon a small scale by placing a piece of zinc beneath the tongue and a piece of silver on top.

On bringing them together, this peculiar sour taste will be perceived, which has been ascribed to the formation of nitric acid by the electro-catalytic union of the nitrogen and oxygen of the air. The induced current produces (when moderately applied) twitchings of the tongue. It is supposed that these phenomena are induced directly through the gustatory nerve, just as flashes of light or sounds result when the current is directed to the retina or auditory nerve.

Upon the Motor Nerves and Muscles.—Electrization of a motor nerve results in a contraction of the muscle supplied by the same, which occurs only at the closure of the circuit, and ceases when the current is broken. A more violent effect will be produced when the negative current is applied to the nerve, and the positive to the muscle, even with a less amount of galvanic power.

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[1] Two other phenomena are produced by the electrization of these parts, viz., an increase of the salivary secretion and a metallic taste in the mouth.

Remak[1] describes a condition of the nerve that follows the passage of a galvanic current of high tension through its length. This he calls *galvano-tonic contraction*. The muscle supplied by the nerve remains in a state of tonic contraction during the passage of the current. Tonic contractions were also produced in antagonistic muscles when the current was sent through special nerve-trunks. Galvanization of the median nerve, for instance, caused tonic contractions in all the extensors of the wrist and fingers. The *induced* current, on the contrary, produced *clonic* contractions, as did the *interrupted galvanic* current. The contraction increases in tonicity with the continuance of the closure of the galvanic current; but with this there is pain, oftentimes very intense. The irritability of the nerve influences the production of the contraction, and, if the current is applied for a long time, the muscle will lose its irritability, and not respond to the stimulus. When a nerve is galvanized for some time, the muscle passes into a state of tetanic contraction, and remains so often when the current is opened. This has been called "*tetanization*."

Dr. John G. Mason has demonstrated, by experiment, that, when one muscle is thrown into a state of tonic contraction, and another is influenced by clonic contractions, in the first the temperature of the muscle will be considerably higher than in the muscle constantly contracting. He selected a rabbit for his experiment, and found that the temperature of the muscle in tonic contraction was two-tenths higher than the other.

Ritter found that when the current was applied directly *with* the nerve, its excitability was diminished; but, if an *inverse* current was used,[2] the sensibility or irritability was increased. From these deductions a peculiar nerve-state has been called:

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[1] "Galvano-therapie der Nerven und Muskelkrankheiten."

[2] From the periphery to the centre.

Electrotonus.—Our knowledge of this state is based upon the fact that each nerve has ultimate electric molecules. In the non-electrified state, these molecules are in what Du Bois-Reymond terms the *peri-polar state;* that is, they are "turned toward each other with equal extremities, so that two molecules form, as it were, only one, possessed of one positive zone and two negative poles." When in the electrotonic state, unequal poles are turned toward each other, and this arrangement is called *dipolar*. This polar arrangement is explained still further by the theory of Pflüger.[1] A certain current passed through a part of a nerve divides this part into two physiological sections or zones, which are different, and pass into one another at a point where the condition of the nerve is unchanged, which is situated at an equal distance from either of the poles. This is called the *point of indifference.* One of these sections is placed in a condition of increased excitability (catelectrotonus) at the negative pole; the other is called the anelectrotonus, and here excitability is diminished, and this is at the positive pole. The state of increased excitability is propagated from the negative pole to either side, and that of diminished excitability goes from the positive in the same manner.

The current belonging to the nerve then runs with, or is opposed by the electric current, producing these phases of irritability.

Muscles possess several properties when influenced by the electric current. One quality has been called *electro-muscular contractility.* The electro-muscular contractility is the susceptibility of the muscle to direct electric stimulation, and the susceptibility to the indirect action (irritation) is called *motricity.* The other condition is known as *electro-muscular sensibility,* which consists of the susceptibility of sensation, accompanying muscular contraction due to electric stimulation. Remak thinks that this sensibility belongs to the sheath of the muscle, though Eckhard is inclined to ascribe it to the nerves directly supplying the muscle.

The demonstration of the two qualities—electro-muscular sensibility and electro-muscular contractility—is occasionally demonstrated in electro-physiology. Some muscles supplied by nerves with motor-fibres in the maximum, are consequently more easily made to contract than when the nerve supplying them contains a preponderance of sensor fibres. With one set of nerves we get increased electro-muscular sensibility, with another, electro-motor contractility with the same current, and *vice versa.* There are certain circumstances which modify the electric irritability of a muscle. Bruises, laceration, and pressure, derangement of the nervous system, etc., etc., diminish it notably.

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[1] "Untersuchungen," etc., p. 95; quoted by Althaus, p. 208.

Upon the Sensor Nerves.—If the electrodes be applied to the surface of the body, a sense of warmth will be felt at the part electrized; and, if the current be strong, it will produce "prickling," and soon extreme pain. Of course the two forms of current electricity produce different impressions. With the induced, if the interruptions be made slowly, they produce but slight stimulation of sensation; but, if they follow each other in quick succession, the intensity of the sensation will increase. The variety of electrode will also govern the effect. A moist sponge will occasion but a mild disturbance of the sentient nerves; but, if a bundle of wires or a plate of metal be applied to the skin, the pain will be almost unbearable. The constant or galvanic current intensifies the sensation, with a peculiar "burning."

The parts supplied most by sensor nerves are those most influenced, the trifacial being that most worthy of mention.

Remak holds that, the nearer the nerve is to the brain, the greater will be the excitability.

The application of the electric current for any considerable time will result in a great diminution of nervous sensibility; the conductors must be moistened, however, and the current continued, to produce these effects.

There is a noticeable difference in the sensations caused by both poles. That of the negative is most intense, and the only way this can be explained is in the consideration that the resistance of the current is at this pole.

Action of the Electric Current upon the Sympathetic.—In the consideration of the effects of the electric current upon the spinal cord, I alluded briefly to the phenomena produced when the sympathetic was irritated at the cervical and lumbar parts of the vertebral column. I will now deal with the effects of the galvanic current upon other portions of this nerve.

The other varieties of electricity have but slight effect upon the sympathetic. Faradism and static electricity give poor results, but galvanism has a direct influence. This current applied to the cervical portion is followed by dilatation, then constriction of the pupil. The pulsations of the heart are at the same time diminished in frequency, and the tension of the carotids and the other arteries is decreased. Althaus[1] speaks of a change in the direction of the carotids, the line of ascension becoming more diverging. There are also changes in the circulation proceeding from the influence exerted on the vaso-motor nerves. The calibre of the arteries is increased. This is verified by observations made by Dr. Geo. M. Beard,[2] who found, in galvanization of the sympathetic, that the arteries of the retina were at first increased in size, and then diminished, and the analogy is, that the vessels of the brain underwent the same phenomena. Dr. Beard's experiments were verified by Drs. D. B. St. J. Roosa and Loring.

Galvanization of the sympathetic certainly results in many important changes in the organs concerned in digestion, assimilation, and secretion, and these must be ascribed to this very influence upon the vaso-motor nerves.[3]

THE EFFECTS OF ELECTRICITY UPON THE OTHER SYSTEMS.

Upon the Heart and Circulatory System.—The heart can be brought under the effects of the electric current by application to the vagi and sympathetici, to the cardial branch taking its origin from the medulla, also by the depressor nerve from the superior laryngeal, and locally.

While the irritation of the sympathetic nerve by the *galvanic* current results in an almost instantaneous decrease in the number of pulsations, galvanization of the vagi will give no results unless the current be strong, when respiration is immediately interfered with, and very seriously. The countenance becomes dusky, and appearances of asphyxia are presented.

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[1] Althaus, "Medical Electricity.," p. 256.

[2] "Observations on the Physiological and Therapeutical Effects of Galvanization of the Sympathetic," p. 7.

[3] Dr. Haimel (*Allg. Wiener Med. Zietung*, 1850–'52) arrives at the following conclusions from his experiments:

The motions of respiration become much deeper, the renal secretion is increased, nutrition is improved, and the weight of the body increases.

Application of the induced current to a point over the right ventricle will cause immediate contractions of the heart.

Action on the Blood.—When the two poles of the battery are passed into a cavity filled with blood, a series of interesting changes follows. At the positive pole we find an accumulation of oxygen, which forms an acid, rapidly coagulating the albumen in its vicinity. At the negative pole a corresponding accumulation of hydrogen, and the collection of a mass of flocculent, curdy substance, called by Smee "artificial chondrin." At the positive pole the fibrine and salts are collected, besides the blood-corpuscles, in a firm clot quite black in color.

Action upon the Organs of Digestion and Secretion.—The stomach, intestines, and other abdominal organs, answer readily to electric stimulation, whether applied to the nerves supplying these organs, or to the organs themselves through their coverings.

Peristaltic movement may be excited either by faradization of the abdomen, or over the different abdominal nervous plexuses.[1] Galvanization of the splanchnic nerves is followed by peristaltic movements, while faradization of the same nerves causes a diminution of these movements. The gall-bladder, when stimulated, contracts violently, and forces out its contents.

The salivary glands respond to the electrical stimulus by an increased secretion.

Upon the Urinary and Sexual Organs.—The ureters, bladder, and male generative organs of secretion, all respond to the application of the electrical current in different degrees of activity. The uterus contracts gradually but violently, particularly if the current be sent in a longitudinal direction, by placing the negative pole on the cervix uteri and the positive on the spine.

Upon the Absorbents, and Nutrition.—Richardson and others have demonstrated the peculiar and rapid absorption of liquids, medicine, chemicals, etc., into the system, through the agency of the electric current.

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[1] Le Gros and Onimus.

Von Brüns and Bur, of Vienna, first demonstrated the fact that if a solution of iodide of potassium was applied to any part of the body (particularly a part where the integument was thin) and an electrode applied at the moist place, and another at some remote locality, free iodine would appear under this last electrode.

In the processes of nutrition, the activity of endosmosis and exosmosis is excited, and the different oxidations are influenced. The production of urea is greatly increased.

Upon the Skin.—An observation of the effects of both currents upon the integument may be most advantageously made when we come to apply them as therapeutical agents. The phenomena are mostly all due to changes in the vascular supply.

When the faradic current is applied to the skin, there is a paleness at first, due to contraction of the coats of the vessels beneath; this is followed by redness. If the skin be dry, these appearances are more marked; but, if it be damp, the current will pass to deeper parts with greater facility. A strong galvanic current produces an aggravation of these conditions, and may result in destruction of the tissues in immediate contact with the electrode. The negative current has the power to diminish the blood-supply in a part, and finds its place in electro-therapeutics as an agent for the dispersion of cyanotic spots and other abnormal collections of blood in the capillaries.

ELECTRO-THERAPEUTICS.

CHAPTER IV.

GENERAL CONSIDERATION OF ELECTRO-THERAPEUTICS.

Nomenclature.—Difference between the Two Currents.—Their Characteristics.—Electrodes.—Sponge Electrodes.—Duchenne's Electrodes.—Metallic Electrodes.—Points de Duchenne.—Duchenne's Cup.—The Electric Scourge or *Brousse.*—Double Electrodes, Rheostat.

In the selection of the current, much confusion has been occasioned by the number of terms used in the designation of the two currents. This can be averted by the selection of two, which are generally accepted. These are—

1. The galvanic current.
2. The faradic current.

The galvanic has the following synonyms: primary, constant, continuous, direct, etc., etc.

The faradic is known as the induced, interrupted, secondary, indirect, electro-magnetic, etc.

A galvanic current may be broken up into shocks by a rheotome, and then it is known as "the intermittent or interrupted *galvanic* current."

As I have before said, and as the preceding pages show, there is a vast difference between the actions of the two currents. Grave mistakes undoubtedly occur through an injudicious use of either, from an improper length of application, or an excess of strength or intensity. Other conditions also influence their administration, and these are: the state in which the patient is; whether there is *exalted sensibility* requiring a mild current, or a condition where the current can be borne with indifference. Then, again, the health of the patient, the existence of central lesions, sex, age, and other influences.

Serious disorders may be produced by improper electrization, such as cerebral congestion, eclampsia, neuralgia, etc.; an *inverse* current often producing these dangers.

On the other hand, its value is shown in cases of atrophic diseases, in asthenic conditions, and other like disorders.

Great improvements have been made in instruments since the days of quackery, and we now have scientific apparatus, electrodes, batteries, and machines. It is our object to treat special parts—nerves, muscles, or other organs—with some definite purpose, and we should avoid the examples of the charlatans of other times, whose only ideas were derived from the use of two tin handles, or the indiscriminate "pawing" or aimless sponging of all parts of the body.

Electricity may be used:

To stimulate muscular power and prevent atrophy; to promote assimilation or secretion; to excite peristaltic action, absorption, and circulation; to overcome depressed states of the system, whether from extreme exhaustion, narcotic poisoning, syncope, or suspended animation; to correct deranged sensation; to relieve pain (neuralgic or otherwise); to act revulsively on the nerve-centres in various central disorders, even including some chronic inflammations, congestions, etc.; by its chemical action, to coagulate the blood, as in aneurisms and varices; to alter and remove tumors and glandular swellings, and as a surgical agent in cauterization, etc.

We have briefly considered static electricity; it is therefore hardly worth while to again refer to the subject; suffice it to say, it has been used in chorea, hysteria, epilepsy, paralysis, nervous deafness, rheumatism, and amenorrhœa. Galvanism and faradism meet almost all indications, however, and should be given the preference.

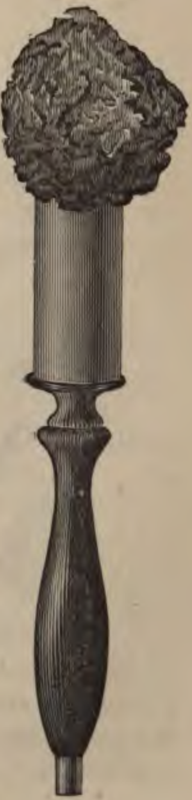
GALVANIZATION AND FARADIZATION.

The relative difference between the two currents, and the advantages over each other, may be considered as follows, and the comparative table on the next page will show their respective virtues:

The Galvanic Current	*The Faradic Current*
Has a great power of overcoming resistance, hence it is adapted when deeper parts are to be influenced.	Has but feeble power in overcoming resistance, and is used generally for stimulation of superficial parts.
It produces muscular contractions more violently, and even when the faradic fails to do so.	The rapidity of the interruptions which characterize this current enables it to produce muscular contractions more *quickly* than the galvanic.
	Its direct stimulating effects on the skin are more violent.
The electrotonic and catalytic effects are marked.	Its electrotonic and catalytic effects are feeble.
It is employed always as a catalytic.	It is rarely employed as a catalytic.
Its thermal effect is an important characteristic.	Its thermal effects are of very low order.
	Faradic currents do not produce the head-symptoms which are caused by the galvanic.

ELECTRODES.

Fig. 14.



The galvanic and faradic currents are applied to the various parts by instruments known as electrodes. These are almost innumerable, and for every particular variety of electrization we have an electrode adapted to the part. Those in most common use, and by far the most important, are covered with sponge. The selection is large, and the shapes are many. I append cuts of those manufactured by instrument-makers in this city. Fig. 14, made by Mr. Meyer, is applicable for all ordinary electrization of small muscles, but for large muscles, where the desire is to bring considerable surface under the influence of the current, I am in the habit of using either A or B (Fig. 15), which are larger. Duchenne has invented two sponge-covered electrodes, which have the merit of being compact and convenient (Fig. 16).

For the electrization of other parts, we have smaller sponge-electrodes, either narrow or pointed, for application to a nerve or small muscle, or they are elongated for introduction into cavities or fossæ. Some are made with swivel-backs, to be applied, for convenience, beneath the clothing.

Again, other electrodes are not covered with sponge, but permit the bare metal to come in contact with the surface of the body. These may be pointed or flat, and the degree of irritation is increased by the amount of resistance made by the dry skin. These electrodes are particularly applicable when it is the desire of the physician to localize the current to a nerve, the skin, or to a special muscle. Duchenne has invented an excellent instrument, and it is named after him—the "points de Duchenne." Two points, such as depicted in Fig. 17, are inserted into handles, and connected with the two poles of the battery. The pain is intense at the point of application, and when applied to dry skin, and a moderately strong galvanic current used, a lively electric spark will dart from one to the other.

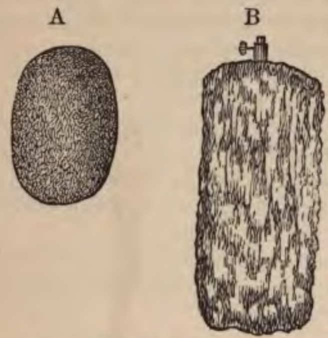


FIG. 15.—One-fifth Actual Size.

"Duchenne's cups" Fig. 18) produce a peculiar counter-irritation when applied to the dry skin, analogous to that produced by the "points," but more superficial.

For muscular and cutaneous excitation, we are provided with the "*brousse électrique*." This instrument, shown in Fig. 19, consists of a bundle of fine wires, or gilt cord, inserted into a handle.

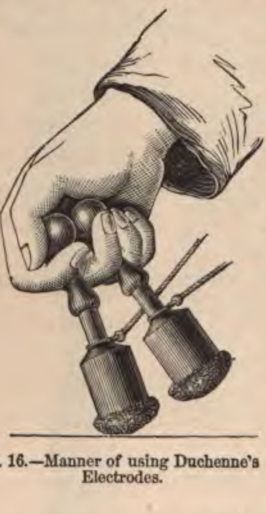


FIG. 16.—Manner of using Duchenne's Electrodes.

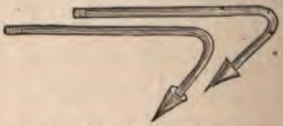


FIG. 17.—Duchenne's Points.

Numerous ingenious electrodes are made, in which the current may be interrupted by simple breakage of the circuit by means of a spring in the handle, and others have been devised where both terminal ends of the poles are passed through one handle. Dr. Piffard, a gentleman who has added to electro-therapeutics many new and valuable inventions, first brought an instrument of this kind to the notice of the profession. Fig. 20 shows the construction of Dr. Piffard's double electrode. Through a handle of ebony, the two wires from the battery pass, each terminating in a copper rod, and these are capped by sponges. The rods are flexible, and may be bent to any degree. Fig. 21 represents an instrument devised by myself, and used for the past year at the New York State Hospital for Diseases of the Nervous System. Through a metallic body pass two rods well insulated, and terminating in sponge-covered ends. These diverge, and may be made to form any angle, and are then retained in position by two little binding screws. From the rods, furnished with thumb-screws, two battery-cords pass to the apparatus.

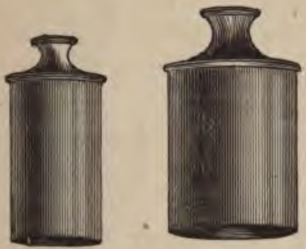


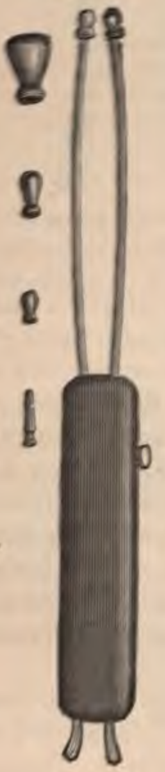
FIG. 18.—Duchenne's Cups.

FIG. 19.

These double electrodes are excellent when the object is to electrize a small muscle or organ. The hand unoccupied may be used for holding the patient.

It is often desirable to regulate the intensity of the galvanic current, and for this purpose an instrument has been devised, known as the *rheostat*. By this arrangement, the resistance of the current can be exactly gauged. This is done by the passage of the current through a greater or less length of wire, so that with one element a weak current can be obtained by passing its galvanism through a great length of wire, or *vice versa.*

FIG. 20.



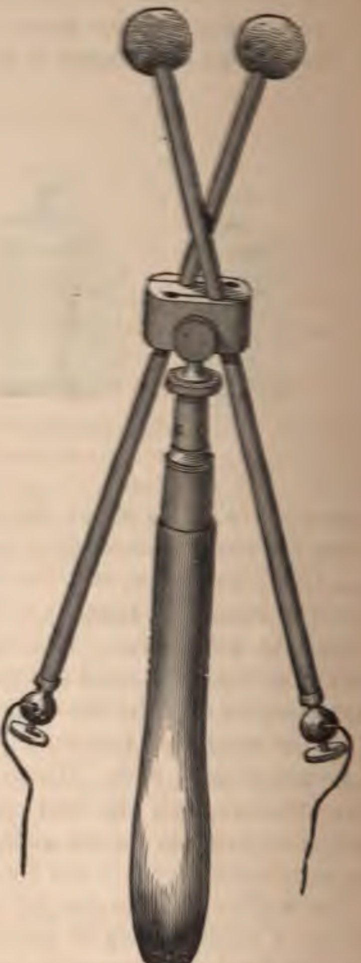


FIG. 21.—The Author's Double Electrode.

CHAPTER V.

GALVANIZATION.

Effects of Galvanization of the Brain.—Of the Cord.—Galvanization of the Great Sympathetic (Central Galvanization).—Diplegic Contractions.—Galvanization of the Pneumogastric.—Of the Ear, Tongue, Eye, etc.—Galvanization of the Rectum.—Of the Urethra.—Galvanization of the Nerves and Muscles.

In the consideration of galvanization, we must bear in mind the rules of electrotonus, and the other phenomena of electro-physiology. We must also consider the effects in health and disease, and the different conditions related in a preceding chapter, influencing the application of the current.

In the exhibition of galvanism, there are two points that it is well to dwell upon.

If we desire to restore diminished sensibility, we use the extra-polar catelectronus;[1] on the contrary, when we desire to subdue an excited or over-irritated state, we use the extra-polar anelectrotonus.[2]

A prolonged application to the surface is very apt to produce disagreeable skin-effects; or, if deeper parts are acted upon, the nerve may be fairly paralyzed instead of stimulated; judgment must be therefore used in employing this powerful agent.

GALVANIZATION OF THE BRAIN.

This may be performed in several different ways. These are:

1. The application of one pole to the forehead, the other to the occiput.
2. The application of one pole to each temple.
3. The application of one pole to each mastoid process.

[1] Ascending current.

[2] Descending current.

In the galvanization of but one hemisphere, we place one pole on the eyebrow, and the other to the mastoid process of the same side.

Althaus recommends that, when the patient complains of frontal pain, fulness, etc., the positive pole should be placed there; but when the sensations are reversed, the occiput being the painful point, the negative pole should be placed in front, and the positive pole on the occiput. It is never well to pass the current for more than three or five minutes at a time, at first.

Flashes of light, which are felt when the current is transmitted, will demonstrate a sufficient force. We should never continue its application when there is vertigo. From ten to fifteen cells are all that will be necessary, though in some cases I have used even thirty cells of the large battery at the New York State Hospital for Diseases of the Nervous System.[1] This great tension, however, will sometimes produce alarming symptoms—not only vertigo and pain, but even vomiting, convulsions, and other violent symptoms.

GALVANIZATION OF THE CORD.

This may be performed by the application of one pole to each end of the spinal column. The positive pole should be placed at the point of disease, if possible. The current should be inverse if the lesion is in the upper part of the cord, but direct if below. We should not prolong the application of the current beyond five minutes. It is unnecessary to use more than thirty or forty cells.

GALVANIZATION OF THE SYMPATHETIC.

The views of Remak, which at first were so greatly ridiculed, and afterward so well accepted (as is the case with all great discoveries), give us the most concise knowledge in regard to the galvanization of this nerve.

Its remarkable therapeutical effects are shown upon remote organs almost entirely. As I have before stated, the two important points that answer to the galvanic stimulus most notably are:

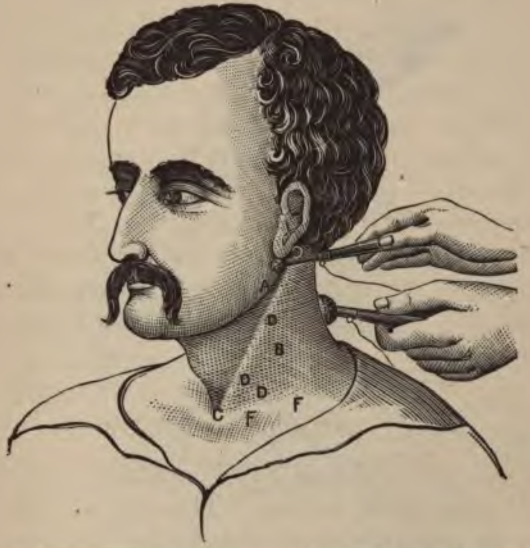
---

[1] Hill's sixty-cell battery.

1. The cervical portion.
2. The lumbar portion.

For the accomplishment of the first form, the negative pole should be applied to the superior cervical ganglion in the auriculo-maxillary fossa, below and behind the angle of the lower jaw, while the positive is placed above the manubrium sterni, to the internal side of the sterno-cleido-mastoid muscle, or to the seventh cervical vertebra (Fig. 22). By the latter application, we have the upper portion of the cord within the galvanic circuit; by the former, the pneumogastric nerve. We may galvanize both sympathetics, if occasion requires.

FIG. 22.



A. Auriculo-maxillary Fossa.
B. Course of Phrenic Nerve.
C. Manubrium Sterni.
D, D, D. Sterno-cleido mastoid.
E. Sup. Clavicular space.
F. Clavicle.

FIG. 23. Electrode for galvanization of the sympathetic.

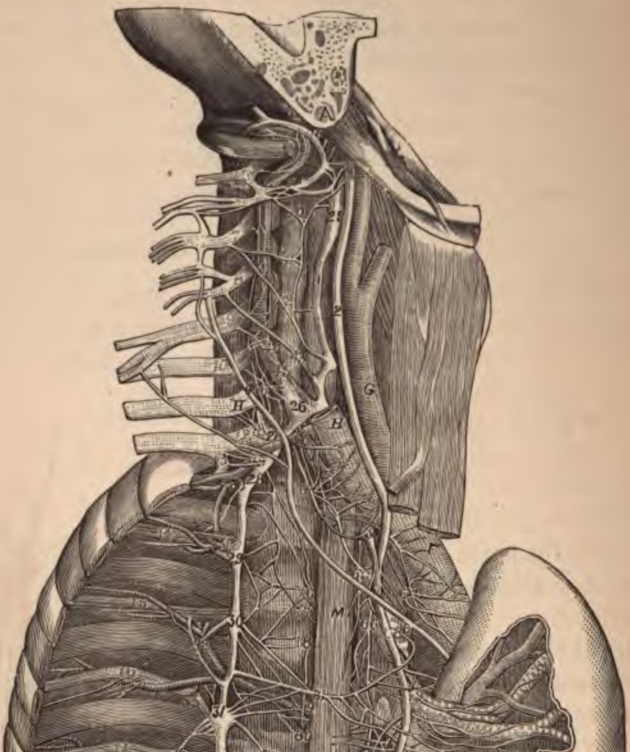
The *séance* should not last longer than two minutes, and no more than twenty cells are to be used.

Galvanization of the lower portion of the sympathetic can be performed, by applying the poles over the fourth lumbar vertebra.

This current affords great benefit when there is a depressed condition of the nutritive processes, and in the treatment of anæmia, diseases involving the vaso-motor system of nerves, in cerebral hyperæmia, and in progressive muscular atrophy.

Remak and Fieber have both witnessed phenomena that occurred when the continuous current was used on patients suffering with progressive muscular atrophy. Certain contractions, reflex in character, were observed, which they denominated *diplegic.* These occurred in muscles in the vicinity of ganglia. They are seen in the maxillary fossa the most dis-

Fig. 24.



2. Pneumogastric Nerve.
4. Phrenic Nerve.
25. Sup. Cervical Ganglion.
26. Inf. Cervical Ganglion.

28.
29.
30.
31. } Thoracic Ganglia of Great Sympathetic.

tinctly. These contractions are chronic in character, and occur also in cases of lead-paralysis. Althaus has observed them in hysteria as well.

GALVANIZATION OF THE PNEUMOGASTRIC.

What I have already said in my chapter upon electro-physiology will enable the reader to see why galvanism, when applied to this nerve, is efficacious in trophic diseases. The anatomical situation of the nerve, and its distribution to the organs of digestion, account for this most fully. The negative electrode (a small sponge) should be placed at the angle of the lower jaw, on the carotid; the positive pole is to be located over the point of origin of the sterno-cleido-mastoid. Althaus fixes the time of application at two minutes.

GALVANIZATION OF THE ORGANS OF SENSE.

For the electrization of the *ear*, we make use of the electrode depicted in Fig. 25. The patient is made to lie on his side, with his head in the same position, the affected ear upward. The electrode is then introduced, and the meatus filled with water; this electrode is then connected with the positive pole, and the negative pole (usually sponge-covered) is placed immediately behind the ear. This is a most perfect way of bringing the force of the current to bear upon the paralyzed auditory nerve. It may be well to place the last electrode (the negative pole) over the opening of the Eustachian tube, or at an external point corresponding to the junction of the gustatory nerve with the chorda tympani. The *séance* should not last longer than three minutes. In galvanization of the tongue in cases of hemiplegia, the electrode shown in Fig. 26 may be employed. Here the application may be continuous for several minutes. It is well to make application to the paralyzed muscles, to preserve their antagonism.

FIG. 25.

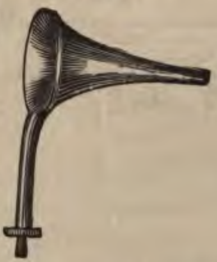
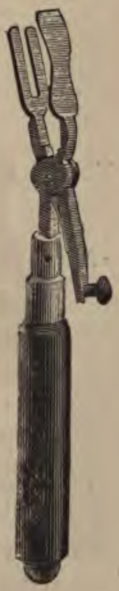
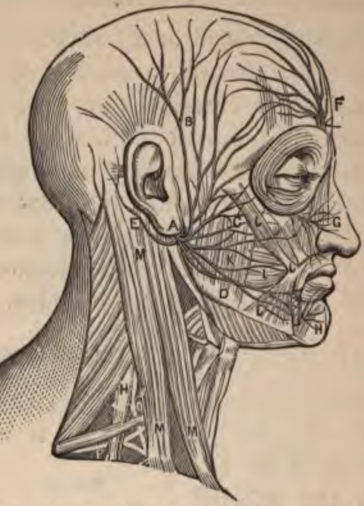


FIG. 26.



When the galvanic current is applied to the eye, we may have recourse to the convenient little instrument, Fig. 28.

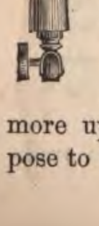
Fig. 27.



A. Facial Nerve at its emergence from the stylo-mastoid foramen.
B. Temporal branches.
D. Supra-maxillary.
E. Post-auricular branch of Facial.
F. Supra-orbital.
G. Infra-orbital.

This should be filled with water and applied over the orbital cavity. It has undoubted efficacy when there is paralysis of the muscles concerned in the movements of the eyeball; also in ptosis and other affections. When sponge-electrodes are used, they may be applied to the angle of the jaw, and over the supra-orbital nerve.

Fig. 28.



Galvanization of the rectum has been advised for muscular atony of that gut. The metallic electrodes, Figs. 29 and 30, insulated to within a few inches of their ends, are to be used, and a moistened sponge must be applied against the abdominal parietes.

Galvanization of the urethra has been advocated by Mallez and Tripier, who have probably written more upon this subject than any other authors. I do not propose to dwell upon their results, but will reserve these for another chapter. Galvanization of the urethra has been advised for spermatorrhœa, impotency, and stricture. In the treatment of spermatorrhœa, the current should be constant, but, in impotency, intermittent. Special electrodes are used like those employed in some of the uterine operations (Fig. 31).

FIG. 29.

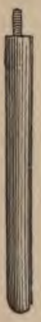
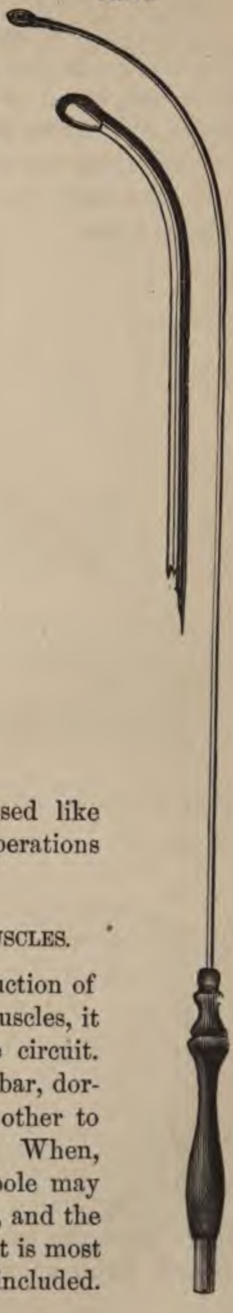


FIG. 30.

FIG. 31.



GALVANIZATION OF THE NERVES AND MUSCLES.

In the use of galvanism for the production of therapeutical effects in the nerves and muscles, it is well to include the spinal cord in the circuit. We may place one electrode over the lumbar, dorsal, or cervical part of the cord, and the other to some muscle or nerve easily accessible. When, however, the cord is not included, one pole may be placed on a superficial nerve or muscle, and the other to some peripheral part. The effect is most satisfactorily produced when the cord is included.

When the paralysis is serious, the action then upon the *central* part (the point of nerve-origin) is excited much more vigorously than when a distant part is also subjected to a local stimulus. Of course, when the lesion is not central, but peripheral, the treatment must be directed to the involved part itself. When the vaso-motor nerves are the seat of disease, one pole should be placed upon the cervical ganglion, and the other to the affected parts.

CHAPTER VI.

FARADIZATION.

Duchenne's Observations.—Methods of Faradization.—Faradization of the Nerves and Muscles.—Electro-Anatomy.—Faradization of the Skin.—Of the Tongue, Ear, Eye, etc., etc.—Of the Rectum, Bladder, Larynx, and Pharynx.—Of the Uterus, etc., etc.

It is to Duchenne that the credit belongs of having perfected the local application of the currents (*l'électricité localisé*), and this mode of treatment is founded on the following observations made by him:

1. When two dry electrodes (metallic cylinders connected with the instrument by pole-cords, and filled with sponge) are applied near one another, upon the thick, dry epidermis, the current does not penetrate the skin, but passes between them, crackling and sparkling.

2. If one of the electrodes be moistened, a superficial sensation is felt under the dry one.

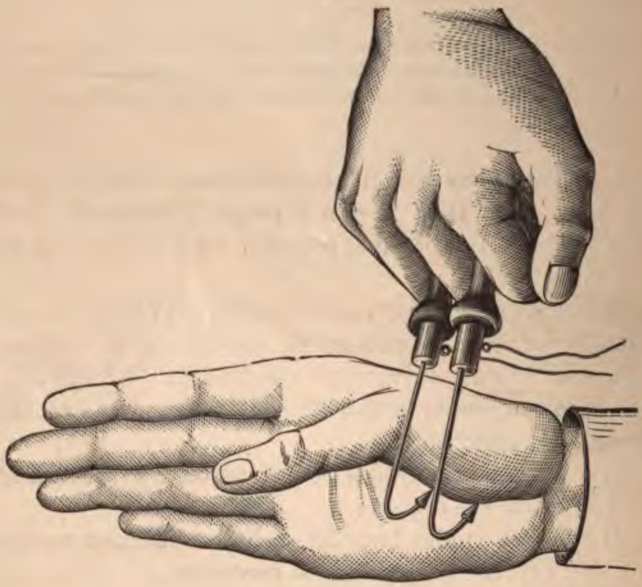
3. If the skin under both be slightly moistened, a stronger though still superficial sensation is perceived.

4. If both sponges and skin are well wetted, there will be perceived neither sparks, crackling, nor burning, but instead, muscular contrations will be excited, accompanied by various forms of pain, according to the depth of the part acted upon.

Duchenne makes use of two terms in the designation of two forms of application, and these are, the *immediate* and *mediate* electrization of muscles. The first is to be performed by applying the electrodes over the muscles, and the second by passing the current through the nerve-trunks. The terms *immediate* and *mediate* have as synonymes *direct* and *indirect*. The electrodes in both cases are to be held closely together, and every muscle, or collection of muscles, made to contract singly by the moist electrodes. The excitors should be placed on the belly of the muscle, if possible, but never on tendons.

Drs. Remak[1] and Ziemssen[2] went still further, and demonstrated anatomically and clinically the spots corresponding to the points of entrance of the motor nerves into the lateral bodies of the muscles. These gentlemen disagree with Duchenne, and insist that the muscular contractions in every case occur through direct stimulation of the nerve.

Fig. 32.



For the faradization of small muscles or nerves, the "points de Duchenne" may be used (Fig. 32).

Muscular consciousness depends upon a difference in sensation between different muscles.

The bones are particularly sensitive to the faradic current, and the electrodes should not be allowed to rest on the subcutaneous points of the body. This is accounted for by the fact that the current penetrates to the nerves of the periosteum.

---

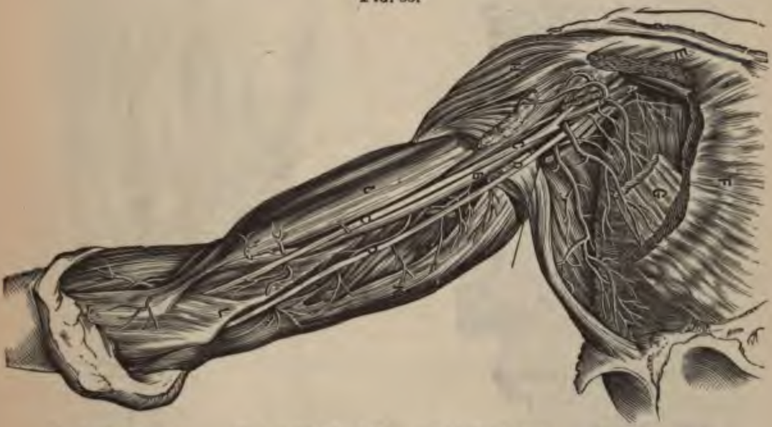
[1] "Uber methodische Electrisirung gelähmter Muskeln," Berlin, 1856.

[2] "Die Electricität in der Medicin," Berlin, 1857.

FARADIZATION OF THE MOTOR NERVES AND MUSCLES.

The exact knowledge of the anatomical relations of the diseased part is of the most vital importance. In the arm the stimulus may be applied to the median nerve, on the inner and inferior third of the humerus, next to the brachial artery, and to the *ulnar* nerve, in the space between the olecranon process and the internal condyle.

Fig. 33.



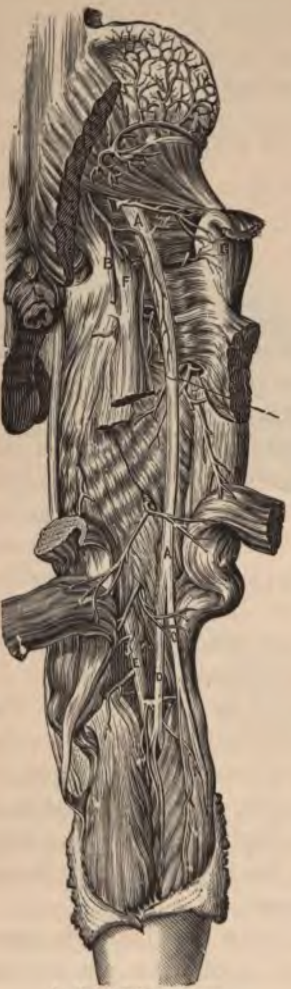
A. Axillary Artery. B. Brachial Artery. C. Median Nerve. D. Ulnar Nerve.

The *radial* nerve may be faradized at the junction of the two upper with the lower third of the humerus. The *musculo-cutaneous* may be reached in the axilla. As regards the lower extremities, we may faradize the *crural* nerve in the groin outside of the femoral artery, and the *sciatic* either on its origin in the pelvis, through the posterior wall of the rectum, or near the tuberosity of the ischuim, behind the head of the femur.

The *obturator* nerve may be reached near the obturator foramen, by placing the electrode vertically to the horizontal ramus of the pubis. The *peroneal* nerve is accessible at the posterior circumference of the head of the fibula, while the *tibial* may be faradized in the middle of the posterior surface of the knee-joint.

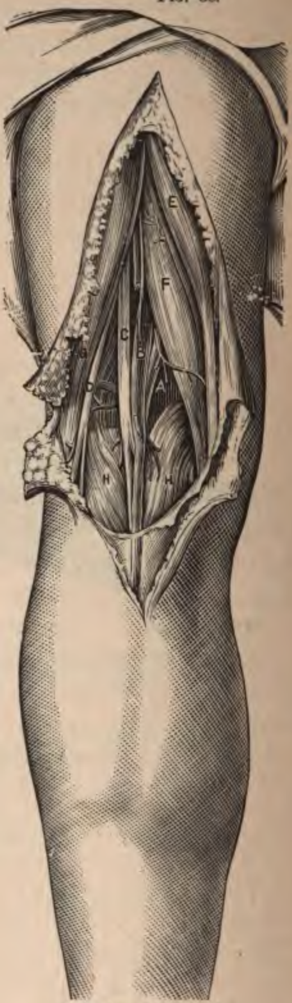
The *portio dura* may be acted upon in the external meatus, by pressing a moistened conductor to the lower side of this canal. This proceeding is painful, and it is more advisable to faradize the nerve after its emergence from the stylo-mastoid foramen, between the mastoid process and the condyloid pro-

Fig. 34.



A. Great Sciatic Nerve.
C. External Popliteal Nerve.
D. Post-Tibial Nerve.

Fig. 35.



C. Internal Popliteal.
D. External Popliteal.

cess of the lower jaw. The larger branches of the *pes anserinus* may be faradized where they emerge from the parotid gland.

In the supra-clavicular region the directors, placed on the clavicle, act on the *brachial plexus*. On top of the supra-clavicular triangle they are in connection with the external branch of the *spinal-accessory* nerve. The *phrenic* nerve is found on the anterior surface of the scalenus anticus.

FARADIZATION OF THE SKIN.

Duchenne has given to us three methods with which to perform faradization upon the skin. These are—

1. The electric hand.
2. The electric brush, or whip.
3. The metallic excitor.

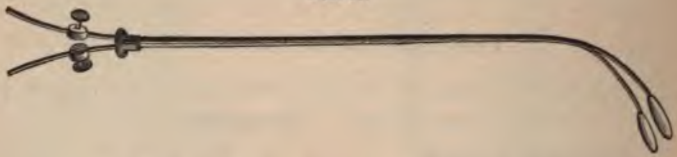
I have described the electrodes for the two latter methods in a previous chapter, and I will not refer to them, except it may be to say that the surface of the skin should always be dry. In callous or horny parts, such as the soles of the feet and palms of the hands, we may find it necessary to slightly dampen these places. The *electric hand* may simply be described as the hand of the operator, who grasps one of the sponges, and passes the unoccupied fingers over the surface; the other pole is applied to a remote part. These methods are strongly recommended in cases of anæsthesia, neuralgia, and muscular rheumatism. The secondary current should be used; that is, the current induced in the external coil that surrounds the magnet. The strength of the current should be regulated in parts where the sensibility is intense, and where the sensor nervous supply is great. The face is exquisitely sensitive. Where the skin is thin, we find this condition more marked. *Faradization* may be applied to the auditory meatus in the way alluded to in the discussion upon galvanization of the ear.

For the application to the Schneiderian membrane, in cases of loss of sense, a moistened electrode should be put on the nape of the neck, and another passed over the whole of this membrane.

Faradization of the rectum may be performed with the instrument shown in Figs. 29 and 30. All substances should be removed therefrom first by an enema, however.

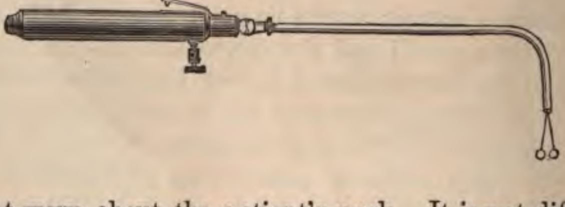
Duchenne's instrument for the application of this current (Fig. 36) in paralysis and atony of the bladder, consists of two wires insulated by a catheter, and terminating in two blades, which may be collapsed till the instrument presents the appearance of an ordinary catheter. It is better and more practicable to introduce an ordinary metallic sound (well insulated) into the bladder, and apply a sponge-covered electrode over the symphysis pubis. Reliquet suggests that the bladder be filled with water by means of a catheter, and that the current should be passed through the column of water in the catheter.

FIG. 36.



The application of electricity to the pharynx and larynx may be easily performed by the instrument depicted in Fig. 37. When we faradize the vocal cords, the laryngoscopic mirror must be brought into play. The other pole is connected with a necklet worn about the patient's neck. It is not difficult to faradize the lateral adductor muscles of the vocal cords. The central adductor may be electrized by placing the conductor on the posterior surface of the arytenoid cartilages. External faradization of the larynx[1] in all cases is a simple procedure. The wire brush is used for this, while the remaining electrode is placed at the nape of the neck. Mild currents must be employed.

FIG. 37.



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[1] Faradization of the skin.

FARADIZATION OF THE UTERUS.

This important branch of electro-therapeutics has received a great deal of attention of late, as it well deserves; for it is impossible to help realizing its virtue in many diseases of this organ.

The patient should lie on her back, and the operator, after introducing a speculum, is to put the uterine electrode (A, Fig. 38) in connection with the external os, after which an olive-shaped director (B) is introduced into the rectum, and a metallic plate, covered with moistened sponge, is placed over the os pubis. This latter communicates with B by means of a bifurcated conducting wire, with one of the poles of the appa-

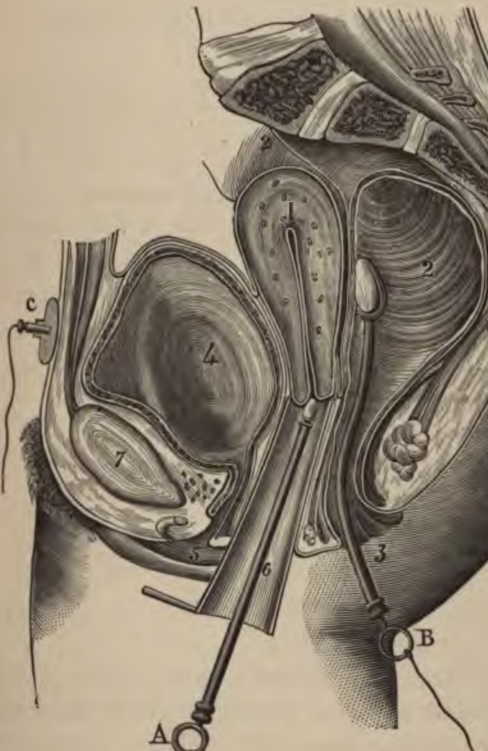
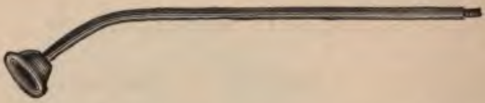


FIG. 38.—(After Althaus.)

ratus, while the other pole is connected with the uterine electrode (A). In unmarried women, or when in the married the engorgement is not combined with displacement, the womb may be faradized by simply using the plate over the os pubis, as before, and a moistened conductor applied to the lumbar region. The application of the current should not exceed five minutes at a time (Althaus). Fig. 39 is a "cup-shaped" electrode for the uterus, which I consider superior to the electrode advised by Althaus. Faradization of the mammæ is advised by Powell, when the secretion of milk has been stopped.

Fig. 39.



I shall speak at length of faradization of the diaphragm in a future consideration of electricity as a resuscitative agent in suspended animation.

CHAPTER VII.

DIAGNOSIS BY ELECTRICITY.

Diagnosis by Electricity, etc.

For the diagnosis of paralysis and kindred diseases, we have an all-important agent in electricity, and, by the careful study of the observations of Dr. Marshall Hall, we can determine to a certainty the seat of disease.

Dr. Hall divides paralysis into two kinds, spinal and cerebral. "Spinal paralysis"[1] is not necessarily associated with a disease of the cord, but may exist in a muscle or group of muscles where connection with the cord has been severed, and are consequently without nervous supply. There may be a loss of voluntary power if the cord is diseased, or there may be simply paralysis of the muscle itself. Dr. Hall's term means, in fine, the functional separation of the muscle or muscles from the cord. Cerebral paralysis consists in the fact that connection between the muscle and brain is interrupted. There may be a lesion of the cord, but this does not have any direct connection with the paralysis.

A most important consideration in making a diagnosis by electricity is that of the qualities alluded to in a previous chapter, viz., *electro-muscular contractility*, and *electric irritability*. The following principles must also be observed in regard to the existence of these conditions:

1. When a muscle is removed from the influence of the cord by destruction of its nerve, or destructive disease of the cord at the origin of the root, it loses its *electric irritability* very

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[1] This term, as used by Dr. Hall, simply implies a functional paralysis; Althaus substitutes the term "peripheral paralysis."

quickly. This condition varies in proportion to the amount of interference between cord and muscle.

2. In brain-disease itself, there is a diminution or an increase in the contractility of the paralyzed muscle to the current.

3. In spinal disease, when a part of the cord is divided, the *electric irritability* is diminished in the muscles which have their origin below the cut portion of the cord. If the nerves come from a healthy region, irritability is not influenced.

4. Section of the nerves between the muscle and cord produces the same results. Paralyzed muscles respond more slowly to the same amount of current (same tension) than do those that are healthy. This may be demonstrated by the simultaneous application of currents of the same intensity to two limbs —the paralyzed one and that which is good. If ten cells will cause response in one, and not in the other, we may infer that the limb responding has a higher phase of *electric irritability*. In the London *Lancet*, April 16 and 23, 1870, pp. 539 and 575, Dr. Russell Reynolds says of this: "To test the true irritability of the muscle, you ascertain its readiness of response to a low power. If muscle A will act to a current of five cells, and a muscle B will act only to a current of ten cells, then muscle A is more irritable than muscle B. If the muscles of the right arm will act to a current of lower power than those of the left arm, then the muscles of the right arm are more irritable than those of the left. You must remember the difference of strength between the direct and the inverse current; and, in testing the irritability of the two arms respectively, be careful not to send the current up the one arm and down the other, and lose sight of that fact in your interpretation of the phenomenon. You often find, when applying a strong current of electricity to two limbs, one of which is paralyzed and the other healthy, that the muscles of the latter act much more vigorously than those of the former. You are not, however, to infer from such observation that the muscles so acting are more irritable. They are often less irritable than the others, but they are stronger, and when you put them into action they act more vigorously. In the one case you are testing irritability; in the other you are testing power. To ascertain, then, the irritability of a muscle, i. e., to see how irritable it is, you must

reduce the strength of the current you employ, whether faradic or galvanic, to the lowest point that will produce contraction. With a more powerful current, all that you will show is that one muscle is stronger than the other; for you lose sight of the finer differences of irritability in the obvious presence of the coarser differences of strength. If we take four or five cells of a galvanic battery, and apply the current, made and broken slowly, to a paralyzed muscle, we often find that it will respond much more readily than will a healthy muscle, because it is more 'irritable.' But, if we take thirty or forty cells, or a faradization-machine, we often find that the same healthy muscle will perhaps draw the hand out of the water, while the other (the paralyzed muscle) will merely give a little jerk. The healthy muscle in this case, though less irritable, is more strong."

Electricity may be used as a test for imaginary or feigned disorders. If we find, after careful application of the current, that there is a difference in the muscles on either side, as in hemiplegia, we are justified in believing that the patient is not shamming. In a suspected case, when a strong current is applied, it is impossible to resist the *electro-muscular contractions* of healthy muscles. Going further, we may base our diagnosis upon these rules.

If the electric contractility of a paralyzed muscle is manifested, we may infer that its relationship to the cord is good, and that there is no intermediate severance of connection. There may exist brain-disease, interfering with the will, but the relationship between that portion of the cord furnishing nervous supply and the muscle is perfect.

If contractility is increased, we may infer the same thing, but also that there is increased irritability of the brain or cord, probably due to increased vascularity of these organs.

This state subsides in a few days in the patient, when slight contractility may reappear, and, after a little longer, when hyperæmia occurs, the contractility will be vastly increased. For this explanation, I take a case of cerebral hæmorrhage. With the excess of irritability, there will be either clonic or tonic contractions, and we should not endeavor to make further efforts at diagnosis, for it will be at great risk to the patient.

Hæmorrhage, sclerosis, and myelitis, or the pressure of a tumor, may give a phase of excessive irritability. The lesion, if it be in the upper part of the cord, may result in a loss of electric contractility in the muscles above, but an excess of irritability in the muscles lower down. With this state there will be a condition of reflex irritability, e. g., tickling the soles of the feet will incite spasmodic movements.

In those cases where contractility is diminished, we find that there is disease of the brain, which eventually ends in paralysis and consequent loss of contractility. There may also be disease of the cord or the nerve. The impregnation of the blood with some poisonous substance, whether narcotic medicines or some of the metals, will produce a state characterized by diminution in muscular irritability.

After cerebral hæmorrhage, when a tumor or softening exists, there will be reduced irritability of the muscle, due to wasting of the nerve, and atrophy. Electricity in these cases improves nutrition, and the depressed tone is heightened, but the central cause remains, and, when treatment is suspended, there is a relapse.

When there is no response to the current, we may be sure the disease has invaded the cord.

With true spinal paralysis (actual disease of the cord), we shall find the same phenomena, with loss of irritability and contractility in the muscle. General treatment and galvanism will remove the cause in time, by reflex irritation of the central parts, through stimulation of the peripheral end of the nerves.

In certain conditions, such as facial paralysis, we have illustrations of that form of paralysis when the nerve is divided or interfered with between the centres of supply and the muscle or muscles. In these very cases there is a diminution or loss of electric contractility in proportion to the damage done. This loss of contractility may occur within from a few hours to several days after a sudden lesion; it may come gradually when the interruption of voluntary power is tardy. Electricity will not restore contractility when communication is effectually destroyed, but it will restore muscles that are atrophied. The application of the current, and the failure of good results, will tell us that the case is incurable, and exactly how much of the paralysis is due to disease and how much to want of muscular use.

There is a loss of electric contractility sometimes which follows paralysis of the muscle itself, whether produced by a blood-poison, exposures, sudden blasts of wind (*coup de vent*), or other local causes. Here the paralysis is confined to certain muscles or groups of muscles, and bears no relation to special trunks. The deltoid, the muscles of one leg or arm, the facial muscles, may be paralyzed. We can here employ the electric current to differentiate these local paralyses from those of the central form. Different conditions may exist in one region; for instance, the hand will be hyperæsthetic, and the deltoid devoid of contractility, or *vice versa.* When this paralysis occurs in a muscle on account of malnutrition, the paralysis will be irregular, and the electric irritability not always present. One peculiarity in the electric diagnosis of this disease is, that electric *irritability* will not respond to a quickly-intermitted current; by the faradic not at all. Galvanism uninterrupted produces no contractions; but, if the current be *slowly* interrupted, it will meet with a response.[1] In cases of lead-poisoning, facial paralysis from cold, etc., these observations are well verified. When muscular irritability is diminished by faradization and galvanization, the disease will be difficult to cure.

Several of the German writers have advised electricity as a means of detecting death in doubtful cases. Muscular contractions will indicate that life is not extinct.

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[1] This is explained by the fact that slow interruptions diminish the over-sensitiveness of the muscle. When contractility gradually returns, faradism, and finally interrupted galvanism may be used.

SPECIAL ELECTRO-THERAPEUTICS.

CHAPTER VIII.

PARALYSIS.

The Use of the Currents.—Modification of the Currents in Special Paralyses, etc.—Cerebral Paralysis.—Diagnosis of Cerebral Paralysis.—Seguin's Thermometer.—Æsthesiometers.—Dynamometer.—Treatment.—Prognosis.—Spinal Paralysis.—Peripheral Paralysis.—Lead-Paralysis.—Hysterical Paralysis.—Infantile Paralysis.—Traumatic Paralysis.—Facial Paralysis.—Reflex Paralysis.—Paralysis of the Bladder.—Rheumatic Paralysis.—Dysphonia and Aphonia.—Glosso-labio-pharyngeal Paralysis.—Progressive Locomotor Ataxy.—Progressive Muscular Atrophy, etc., etc.

ELECTRICITY meets its most important indication in this class of disease. Its curative action has been so efficient, complete, and satisfactory, that cases which were formerly given up as hopeless are now very often greatly relieved, if not permanently cured. After reading the last chapter, we can pretty nearly discriminate those cases capable of being benefited, and we are enabled to understand how to direct our treatment. In fact, it is absolutely necessary to make our diagnosis before doing any thing at all. After having settled upon a diagnosis, we are to observe the following rule: It is absolutely injurious to use the currents when the central lesion exists, consequently we would not think of employing it in recent cerebral hæmorrhage, or paralysis resulting from some acute inflammatory condition. These cases are recognized by the greatly-increased electric irritability, and the rigidity of the muscular contractions.

The principles of electrotonus must be borne in mind. A descending current will be accompanied by a diminution of nervous irritability at the positive pole, and an increase at and above the negative. These results will be the same, but *reversed* if the current be changed and made *ascending* or *inverse*, and below the irritability will be diminished, while above the current will be increased. These phenomena are exaggerated if the current be reversed (the polarity changed). With these sudden interruptions or reverses of the current, there will be greater central effect, the intervals taking the character of shocks, oftentimes very severe. It is unwise to use the inverse current near the head, as the causation of central irritation is almost inevitable.

Faradization should be employed in those cases where there is an impaired state of electro-muscular contractility. If a cerebral or spinal lesion exists in an acute form, it will do but little good. It is therefore indicated more as a secondary means, to prevent atrophy, to stimulate the vessels of the paralyzed muscles, and the small nervous branches in their substance. In cases of local paralysis, whether from injury of the nerve or not, we can employ it with the hope of good results. In all cases where there is an existing cause, we must remove that cause before we can expect success. We must also closely examine the paralyzed limbs, for the paralysis is not always general; there may be motility in some muscles and not in others, consequently it would be unwise to faradize both the sound and paralyzed parts. In certain wasting diseases dependent upon atrophy of the muscles, such as progressive muscular atrophy, when the muscles respond to the electric stimulus, we have the most gratifying results. Dr. C. Hilton Fagge, assistant physician to Guy's Hospital, reports several cases in the *Practitioner*, which certainly show the most brilliant results attending a proper use of this remedy.

Electro-puncture was advanced by Remak as a means for producing the effects of the electric currents in the deeper paralyzed muscles. It has had efficacy, but I do not advise this most painful practice, which entails a vast amount of unnecessary suffering.

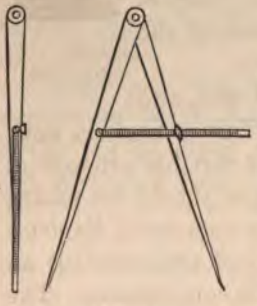
CEREBRAL PARALYSIS.

The occurrence of the effusion is usually followed by a period of some weeks, when the use of electricity would not only be dangerous, but perhaps fatal. At this time an inverse current would increase the irritability, and perhaps produce a fresh apoplectic attack. When we have convinced ourselves that the irritability at the point of effusion has subsided, we may begin treatment. In doing this, we are to gauge the electric irritability of the muscles (their contractility), and are to take into consideration the state of the patient, his age, and other influences. If the lesion has been produced by embolism, softening, or disease of the brain-substance, we must also be guarded in the exhibition of our treatment. We must *wait for absorption to be well under way.* A proper use of the *direct* current must be made to hasten this, and a mild faradic current locally to prevent the atrophy of muscular tissue till the cerebral mischief is over.

It is well to observe a proper medium in the time of application, for, if we begin too early, the bad results I have just alluded to will follow; if too long after the hæmorrhage, we shall find that the response to stimulation will be weak. In muscles long paralyzed, the electric contractility will not respond to the faradic current, but a rigid and sometimes violent contraction will follow the galvanic. Daily *séances* should be made. The faradic current may be used in the following ways:

1. One pole to some central locality, i. e., the lower part of the vertebral column, and the other to some peripheral point.
2. One pole at one end of a muscle, and the other at its point of insertion.
3. Mediate electrization (*vide* p. 57).
4. Immediate electrization.

Fig. 40.



A galvanic current of moderate tension may be directed through the head. This treatment, with an auxiliary use of strychnia, iron, and phosphorus, will improve most cases of hemiplegia. During our treatment, we should test, from week to week, the cutaneous sensibility. This may be done by an ingenious little instrument known as the æsthesiometer.

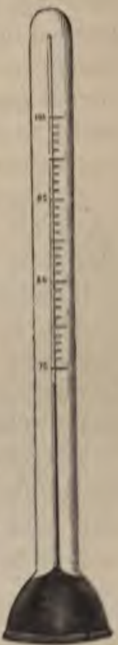
Fig. 40 represents that form known as Hammond's æsthesiometer. The approximation of the two points will indicate the extent of morbid sensibility. When these points are brought together, the patient will distinguish both of them simultaneously at a certain distance of separation between the points. The minimum normal distances at which the two points can be distinguished in different regions of the body are as follows:[1]

Point of the tongue	½	a line.
Red surface of lips	2	lines.
Dorsal surface of third finger	3	"
Metacarpal bone of thumb	4	"
Palm of hand	5	"
Mucous membrane of hard palate	6	"
Dorsal surface of the first finger	7	"
Mucous membrane of gums	9	"
Lower part of forehead	10	"
Lower part of occiput	12	"
Back of hand	14	"
Neck under the lower jaw	15	"
Skin over the patella	16	"
Skin over the sacrum	18	"
Skin over the sternum	20	"
Skin over the lumbar region	24	"
Middle of the arm	30	"
Middle of the thigh	30	"

In disease, the distances will be greater or less, according to the hyperæsthesia or anæsthesia.

The thermometer should also be used. Dr. Seguin's improved thermometers, with broad bases, are excellent instruments, and with two of them placed simultaneously on the skin, we can compare the difference in temperature in two parts of the body—the paralyzed and the non-paralyzed.

FIG. 41.



Dr. Seguin's Surface Thermometer.

The muscular power should be tested also, and this may be done by the dynamometer. This instrument must be grasped in the hand, and *one* slow and forcible attempt at squeezing the two flat borders of the ellipse should be made; the ends *a* and *b* will be expanded, and the transverse diameter diminished. With this movement a toothed arm revolves an indicator, which registers the extent of the compression. The relative scale indicates the muscular power of the hand. This instrument is ingeniously constructed to register the force exerted after the effort is made. It was invented by M. Mathieu of Paris, and first introduced into this country by Dr. Wm. A. Hammond.

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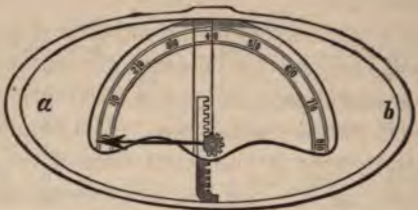
[1] "Diseases of the Nervous System," Hammond, p. xvii.

FIG. 42.



CASES.

The prognosis of cases treated in the manner I have described, is exceedingly favorable; in fact, it is impossible to thoroughly and quickly restore a paralyzed limb without electricity. The existence of softening makes the prognosis invariably bad, the relief afforded being only temporary. If the patient's condition be such that there is a gradual breaking down, I doubt if electricity or any other mode of treatment will do any good. When the paralysis is so complete as to involve the sphincter ani and the muscular fibres of the bladder, improvement is unappreciable.[1]

I. *Right Hemiplegia, the Result of Thrombosis, with Ataxic Aphasia.*—W. W., aged thirty-one. In March, 1868, first noticed the symptoms of formication; numbness and feelings of heat and cold in the right side. In two weeks these symptoms advanced till they reached the shoulder; there was no loss of consciousness. On the 11th of May, the patient lost the power of speech, and did not regain it at all till four months afterward, when he was able to enunciate, in a very indistinct manner, a few words.

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[1] Dr. Emil Fliess, of Berlin, relates the results of the treatment of eighty-five cases of hemiplegia with the constant current. The patients were of all ages, and the disease was of most various origin in different cases. Two methods were employed: 1. Galvanization of the sympathetic, by placing one pole on the cervical sympathetic of each side, or else one pole on one sympathetic and the other on the spine or on the course of a cerebro-spinal nerve or on some indifferent spot. 2. Central galvanization; a current being passed either from front to back of the brain, or along the spinal cord or centripetal, two points of a nerve-trunk being included in the circuit. Of sixty-four cases treated by the first plan, five were cured, and nine were much improved; of fifty patients treated by the second method, two were cured, and seven much improved. Seven patients were also cured by the combined use of both methods. Only a slight improvement, or none at all, was noted in the rest of the cases; in one, the treatment did harm.—(*Quoted by Beard and Rockwell*, p. 395.)

The patient was admitted to the out-door department of the New York State Hospital for Diseases of the Nervous System, August 22, 1870, and came under the observation of Dr. T. M. B. Cross, who afterward treated him. His condition was this: "There was hemiplegia of the right side of the body, including the arm and the leg, but the face was unaffected. There was no strabismus nor facial paralysis. The pupils were very much contracted. The tongue did not deviate to either side. Every sense was unimpaired, except tactile sensibility. His intellect was as clear as ever; no loss of the memory of words, no impairment of the motor power of the tongue, but simply a defect in the faculty of coördination of the muscles used in the act of speaking. The patient found more difficulty in pronouncing labials and linguals than gutturals. There was much atrophy of the muscles of the right side of the body, but the process of degeneration was more advanced in the arm. Muscular power in the arm appeared to be nearly abolished. He could not bend the arm on the forearm, nor raise the arm by means of the deltoid. The dynamometer indicated but very feeble power of the right hand. Tactile sensibility, electro-muscular sensibility, and contractility, together with temperature, were markedly diminished in the right arm, while sensibility to pain was normal.

"Patient had but little power in the thigh, could hardly walk, and when he did so it was with a shuffling gait. Heart-sounds natural; urine normal. The thermometer detected difference in temperature. The patient could not whistle, and in talking he had a peculiar hesitating, stammering manner.

"The treatment consisted in the administration of hypodermic injections of strychnia, and the faradic and galvanic currents. The former was applied three times a week to the leg and arm, and to the tongue and lips; the latter to the head, as has been directed by Dr. Hammond. With this treatment, small doses of phosphorus were given.

"*November* 15*th*.—The case has shown the most marked improvement. The patient can articulate words containing many labials and dentals. The muscles of the right upper extremity have increased in strength; he can flex his forearm on the arm, raise the arm at a right angle to the body above his head, and keep it there voluntarily. He walks with greater ease, and lifts the toe off the ground. All the muscles respond to the weak faradic current. Sensibility is gradually returning, while the temperature and nutrition of the limbs are constantly increasing. The patient has so far recovered that he intends to make an attempt to earn his livelihood by engaging in some light business which only requires moderate activity."

II. *Right Hemiplegia—Cure.*—O. S., aged fifty-two, butler, came under my charge October 2, 1872. He had been deprived of consciousness and power of motion a year before, by a cerebral hæmorrhage, and, after resuming the duties of his avocation some months afterward, continued well till three months ago, when a second attack prostrated him; but, through the good treatment he received at Bellevue Hospital, he partially recovered the power of locomotion. When he came to me for treatment, there was complete hemiplegia of the left side. There was no peculiarity in his gait, beyond a very slight dragging. The arm was slightly atrophied, and the amount of power exerted by a forcible grasp of the dynamometer was indicated by 15° of the lesser circle. He could not button his clothes, nor lift his arm above his head. There was no difficulty in speech, except it might be embarrassment in speaking the words containing the letters *b* and *p*, when the labial muscles were required. Electric irritability in the arm was slightly exaggerated. After giving him a simple prescription for his constipation, I dismissed him. In three weeks afterward he returned in very much the same condition. I then systematically applied the galvanic current to the head, and the faradic to the limbs. The improvement was marked and immediate. The muscles lost their atrophic state, and became firmer and larger. The patient was able to perform many actions with his hands not possible before this treatment. Faradization to the lips and cheeks has effectually overcome the facial paralysis, and he now speaks distinctly.

November 20*th*.—He is still under treatment, but improving rapidly.

III. *Cerebral Softening—Right Hemiplegia.*—H. Walker, aged sixty-two, Germany, canal-boat captain, presented himself in December with a well-marked right hemiplegia. He had been injured some time before while on the deck of his canal-boat, and then hit upon the head. He was senseless for some days, but recovered, with severe cerebral disturbance, which, from his wife's statement, must have been inflammation of the cerebral substance. He left his bed after some weeks, with persistent pain in the head, trembling, and a heavy feeling of the lower limbs. His memory and other mental faculties became obscured, and there was an uneasy expression of the eyes. About a year after the receipt of his original injury, while working one day in the sun, he had an apoplectic attack. After remaining in bed some time, muscular power and cutaneous sensibility slowly came back. He was able to walk with difficulty; his speech was thick and indistinct, partaking of the stammering which occurs with softening sometimes. The muscles of both the leg and arm were greatly atrophied, and I determined to use faradism. The constant use of the *very mild* current for several weeks brought back, to some degree, the original contour of the paralyzed muscles. He was able to progress with a cane, but his speech remained imperfect. During the treatment, he had repeated premonitory signs of a new attack, and I was surprised by this state of affairs. Faradism was resorted to, to prevent atrophy, but its good effects are only temporary, as there is still softening.

IV. *Right Hemiplegia—Cure.*—"B. W.,[1] a gentleman, aged sixty-eight, of gouty constitution, first came under my care in June, 1866. He was then suffering a good deal from gravel, and excess of uric acid in the urine, and digestion and assimilation had been imperfect for five or six years. In December, 1866, while dressing for dinner, he had an apoplectic seizure, accompanied with loss of consciousness and paralysis of the left side of the body. For a week he was in a very precarious condition, and I believe his life was only saved by large doses of ammonia and chloric ether, which I ordered to be given at short intervals. He gradually, however, recovered his consciousness and intellect; the face resumed its normal appearance, and the muscles of the arm also improved. Four months after the attack, he was in the following condition: His memory and speech were unaffected, and there were no distressing sensations in the head. The skin of the left arm and leg was cold and flabby, and the pulse weaker in the left than in the right side. There was a feeling of numbness, and a certain degree of anæsthesia, in the left arm and leg. The muscles were relaxed and somewhat wasted, especially the extensors, but there was no rigidity either in the upper or in the lower extremity. Feeding, dressing, and all other movements of the arm and hand were extremely difficult, although with a great amount of exertion they could be performed. The patient could walk comfortably for half a mile, but then began to feel fatigued, and was obliged to rest. From these symptoms I concluded that the clot which had been formed in the right corpus striatum and thalamus opticus, and which had produced the paralysis, had, to a great extent, been absorbed. If, therefore, the original injury had been repaired, the seat of the paralysis was now not so much in the brain as in the motor nerves and muscles, which had been weakened by their long disuse. Faradization was therefore now resorted to, with the result that, after sixteen applications, the bulk of the muscles was increased, the circulation in the limbs was properly reëstablished, and the patient had almost entirely recovered his motive power."

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[1] Althaus's "Medical Electricity," p. 450.

SPINAL PARALYSIS.

If the paralysis be due to actual disease of the cord itself, I do not believe that electricity will be of any avail, except, as I have before said, we treat the bad effects that follow such disease, e. g., atrophy. With these severe cases, there is more paralysis of sensation than with other varieties of disease where there is no lesion of the cord. A tumor in the substance of the cord is a formidable obstruction to success. Cases due to myelitis are good ones, as are those following or occurring with spinal anæmia. Recent cases, and young subjects, are cured in the shortest time, and galvanism has succeeded better than faradism.

Peripheral Paralysis.—In the form of paralysis due to lead-poisoning, traumatic injury of the nerve, etc., etc., I have been most agreeably impressed with the efficacy of the faradic current combined with galvanism. Lead-poisoning is also treated by the electro-chemical bath. In this disease it is difficult at first to obtain response to the faradic current. It is only when the faradic current is slowly interrupted that electro-muscular contractility is shown; afterward, when the heightened excitability is diminished, it is well to follow up with the faradic current. With these facts in view, it will seem evident that the current should be the *direct*, i. e., *with* the course of the nerve-current. Faradization and galvanization of special parts affected, must also be made.

"The prognosis of lead-paralysis is always good, provided the muscles can be made to respond at all to the induced current; and it is still favorable, though more time must be allowed, if they will respond only to the primary current. But, if no response can be evoked by as powerful a galvanic current as it is safe to apply, then it is well to give up the case."

The following table, based upon the researches of Dr. Hammond, will enable the reader to estimate the length of time required in an average number of favorable cases taken from that gentleman's case-book:[1]

Induced Current.	Primary Current.	Condition of Patient.	Time of Cure.
No contractions.	Powerful contractions.		4 months.
Feeble "	" "	Atrophy of all the extensors of wrist and adductors of thumb.	6 "
No contractions.	" "	Extensors of wrist affected.	2½ "
No "	" "	Result of using lead cosmetics.	3 months 20 days.
No "	" "	" " " "	2½ months.
Contractions.	" "		6 weeks.

Judging from this, the cases that recover the soonest are those that respond at once to the faradic current; and those that respond only to the galvanic current at first, take nearly twice the time.

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[1] Clinical lecture, Bellevue Hospital Medical College. Reported in the *Psychological Journal*, June, 1871.

Paralysis from Lead-Poisoning.[1]—"M. C., aged thirty-two years, single, born in Ireland, a painter by occupation. He has been moderately temperate in his habits, and has always enjoyed very good health until 1863, when he was suddenly seized with a very severe attack of colic, which was preceded by great constipation of the bowels and loss of appetite. There soon succeeded nausea and vomiting of bile, accompanied by an acute lancinating pain in the epigastric region, which was so severe that the patient was obliged to lie flat on the floor, and press his abdomen strongly against that surface in order to obtain temporary relief.

"These symptoms continued off and on for a period of about two weeks, gradually diminishing in severity, however, especially after an evacuation from the rectum, which was only obtained with the greatest difficulty. His right leg at this time became œdematous. In the course of two months he resumed his usual avocation, that of a painter, but was not aware, at this time, that his sickness had been caused by the action of lead. During the year 1867 his bowels again became very costive, and his stools, which consisted of only a few lumps of dry, hardened fæces, were attended with much straining. Soon there followed a second attack much more severe than the first, which was characterized by nearly similar symptoms, only there was superadded great tenderness over the kidneys, which were so sensitive that the least pressure caused him the most intense agony. The urine was very scanty and high-colored, and there was a well-marked blue discoloration of the gums.

"In a few months, having somewhat recovered, he went to work again at his former occupation, which he pursued uninterruptedly until the 25th of December, 1869, when, after having passed a very uncomfortable day, his former symptoms returned with increased violence, while the paroxysms of colic came on at much shorter intervals than they had done in the preceding seizures; in fact, instead of intermissions as formerly, there were only remissions of the intestinal spasm. For the first time, he had pain in the feet and the inside of his thighs. The urine was more scanty and higher colored, and the bowels more constipated than before.

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[1] Reported in the *Psychological Journal*, January, 1871, by Dr. Cross.

"In three weeks he again began to work, and had no more trouble, except constipation of the bowels, and weakness in both his upper and lower extremities, until July, 1870, when he lost his appetite, and felt very weary and exhausted after any small amount of exertion. He was very restless, and could not sleep at night, and this inability to sleep was a sequela of all the other seizures. Now came great tremor of the right hand and arm, which was soon followed by tremor in the left. In August, 1870, he had his fourth and last attack, which was the most severe of all, and lasted about two weeks. This time he vomited blood, had acute pains in the soles of the feet, and cramps in the right hand.

"On recovering from the immediate effects of the colic, he found that he was unable to use his arm or hand at all, and that he had lost power in his legs also. Soon after this he was admitted to the Charity Hospital, where he remained for a fortnight, and during his residence in that institution he became delirious, and continued so for about eighteen hours.

"He came to the outdoor department of the New York State Hospital for Diseases of the Nervous System, September 12, 1870, when his condition was as follows:

"There was the characteristic drooping of both wrists, which was very extreme in degree. The paralysis of the supinator and extensor muscles of both upper extremities was exceedingly well marked; the flexors were also involved, only to a much more limited extent. The paralysis was more considerable in the right forearm and hand than in the left. There was much atrophy of all the muscles of these parts, and this was very conspicuous in the abductors and adductors of the thumbs. The patient was so very weak in his lower extremities, that he was unable to arise from the sitting posture without assistance, and as he walked he tottered at every step. Yet, he did not drag the toe of either foot, nor swing his legs, as do those suffering from hemiplegia. The blue line was very plainly seen around the edge of the gums of the upper and lower jaws. On testing the amount of muscular power in the right hand by means of the dynamometer, he was able to turn the indicator only 10°, while with the left he could accomplish somewhat more. The tactile sensibility, sensibility to the electric current, and to pain, were very greatly diminished. The temperature was also diminished; muscular contractility was so much impaired that a powerful induced current had not the slightest effect in causing contractions, and, even when the primary galvanic current (sixty cells and very strong) was used, the muscles responded very feebly, if we except, perhaps, the flexors, so almost completely had their irritability been destroyed. The bowels were regular, the urine was normal, and, although no chemical analysis for lead was made, undoubtedly it would have been found.

"The appearance of the patient was anæmic, cachectic, and depressed; the breath was very offensive; the retinæ were anæmic; the lungs were healthy, and so was the heart, excepting an inorganic murmur at its base."

The treatment in this case has consisted of the internal administration of the iodide of potassium, commencing with ten-grain doses three times a day, and the daily application of the primary galvanic current to the paralyzed muscles, with a hypodermic injection of the thirty-second of a grain of the sulphate of strychnia every day.

September 17th.—The iodide was increased to fifteen grains three times a day.

September 24th.—Slight fibrillary contractions in the right arm were produced to-day for the first time, by means of the faradic current.

October 1st.—The iodide of potassium was increased to twenty grains three times a day.

October 5th.—The induced current had just commenced to cause slight contractions in the left forearm.

November 15th.—Faradization of the left forearm produced good contractions in the extensor corpi radialis and ulnarius muscles. The blue line having disappeared, the iodide of potassium was discontinued, and a tonic substituted.

November 23d.—The muscles of both arms respond feebly to the induced current, yet by means of it the hands can now be extended nearly on a level with the forearms. The right arm has improved the most. Sensibility to touch and to electricity has much improved. His bowels are regular, he sleeps well, and his appetite is good. The power in both hands has much increased, and he is able to work every day, although he is still under treatment.

January 1, 1871.—The patient has almost entirely recovered.

Hysterical Paralysis.—In young girls capable of great emotional excitement, or disturbance, we sometimes meet with this disorder. It is not confined to any special part, but may attack one leg or arm, or only one or two muscles of the body. It usually takes, however, the form of paraplegia. This species of paralysis is purely functional, and the victim may recover without any treatment at all, or it may be a long, distressing malady, suddenly ending in an unaccountable manner. It is often associated with globus hystericus, and other disorders of a like nature. We should use the dry metallic excitor, or the *brush*, to the muscles themselves, and apply galvanism to the spine. Dr. Swain has reported a case in the *Practitioner*, which is as follows:

"*Hysterical Paraplegia in a Patient suffering with Epileptic Mania.*—E. S., a girl of sixteen years of age, suffering from epileptic mania, and never having menstruated, was admitted into the Brookwood Asylum in October, 1868, being unable to use either of her legs, and having in consequence to be carried into the ward on her arrival. Medicine was given to her to open her bowels, and, as she was very restless, a single dose of twenty minims of the liquor opii was administered: this produced sleep. She was anæmic, and generally weakly in appearance. She was both wet and dirty in her personal habits, but whether this was due to the same cause as the paralysis, or to her mental disease, it is not possible to say. A few days after her admission, the use of the electro-magnetic machine was commenced, and was persevered in daily until her entire recovery. It was first tried by her taking hold of the handles; this produced no effect. The handles were then placed to her feet, but for about six days she did not feel any current at all. At the end of that time, however, she experienced a tingling sensation; the machine was used alternately to the feet, hips, and knees. About the end of December, she was enabled to crawl about, and employ herself a little in cleaning the floors of the infirmary in which she was placed. She gradually improved, and during the second week in March she had her first catamenial period. In the beginning of April she suddenly discarded her crutches, which she had used for two or three months; and, at a ball given to the patients in the following week, danced several times, appearing to have quite recovered both sensation and motion. It is needless to say she was much tired after dancing. The epilepsy continued, with occasional attacks of excitement, until December, when she was discharged as recovered. She has since been a patient in the asylum, suffering from the same form of mental disease, but having exhibited no recurrence of loss of power over her limbs.

"It would appear that recovery was not, in this case, due to the appearance of the catamenia, as before that period there had been gradual improvement; and the actual ability to use the legs properly did not occur until three weeks after the menstrual period; therefore, one is led to think that the electro-magnetism must have exerted a decidedly beneficial effect. The dirty habits continued only a short time after a certain amount of sensation had returned to the limbs."

Infantile Paralysis.—Infantile paralysis has a number of causes, consequently it is not *always* idiopathic. It may be due to injury, to reflex excitability, or rheumatism. This paralysis may be partial, or it may assume a general character. It appears also as an incomplete hemiplegia or paraplegia. As in adults, some cases terminate in deformity.

Probably no disease tries the patience of the physician as does this; the cure is often tardy or incomplete, in spite of the fact that muscular nutrition is so marked in the child. It is often months before any result is obtained.

Most of the cases that are brought for treatment are due to reflex causes; for example, ascarides or dentition. These are the best subjects for electro-medication.

Cases of paralysis of the deltoid, rhomboidii, and trapezii, muscles are hopeful ones for treatment. In this condition the relative position of the scapula with the thoracic walls and spines of the vertebræ is changed. The scapula can be kept in place by exertion of the will, but falls back to its malposition immediately afterward.

Faradization of the muscle for a long time was opposed, both on account of the youth of the patients, and the fact that the severe shock upon the nervous system was apt to be followed by convulsions. Duchenne insisted that, with proper care, the use of moist conductors, and the abolishment of the old severe system of dry conductors and metallic excitors, these cases could be treated safely. The induced currents are those that are to be employed (the primary and secondary). The instrument should be capable of producing slow interruptions. The secondary current produces deeper contractions than the primary.

Emanuel Klopsch,[1] *directeur de l'Institute à Breslau*, made a very favorable prognosis for the electro-therapeutics of idiopathic paralysis of children by the following case: The patient was a girl, nine years of age, who had been paralyzed in both legs nine months before the application of electricity; the cause being, as M. Klopsch believed, a serous effusion in the spinal canal. This author, by faradization of the paralyzed extremities, effected a restoration of the sensibility in fifteen days. It is to be remarked that localized faradization was used intermittently and alternately with electric foot-baths, douches, and gymnastic exercises. After four weeks, the patient could stand, and in thirty-four days she began to walk, without crutches or the aid of a stick. Finally, at the end of two and a half months, she walked alone.

The same author reports the following cases: Wally Kreusel, aged twelve years, had a fall on a stone step. By degrees, paralysis supervened, with atrophy of the left leg; the patient dragged this leg, which was drawn up; the left half of the pelvis was depressed one and a half centimetre; the circumference of the thigh and of the leg was shortened to the same extent, besides which she suffered pain the whole length of the sciatic nerve. Faradization of the muscle supplied by this nerve, and the direction of the current of the electric foot-bath toward the trunk of the same nerve, both accompanied with gymnastics, accomplished a complete cure at the end of eight weeks.

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[1] Ullsberger's Prize Essay.

The paralysis disappeared, together with the atrophy; all functional derangement ceased, as well as the pains.

"A girl, four years of age, had been, at the end of eight months, suddenly, without any known cause, after a slight indisposition, deprived of power in the left leg. Ten months after, the limb lost all power of motion. The child could not stand upright. The leg was visibly emaciated, but on measurement no notable difference was perceptible in its length. Electrization of the leg would not produce any motion of the foot, but would feebly flex the leg on the thigh. Faradization for some weeks restored motion at the knee-joint, and the power of flexing the thigh upon the pelvis. The results of ulterior treatment have been most satisfactory: the child has greatly improved; she walks with ease, and we are led to hope that, by persevering, the limbs will regain their normal proportions, and the flexor muscles of the left foot their antagonistic tonic force and voluntary movement."

Case reported by Dr. Rudolphe Wecke, of St. Petersburg: "A land-owner's son, aged five years, of scrofulous cachexia, was paralyzed on the right side, three months after a stroke of nervous apoplexy. The arm and leg suffered an arrest of development, particularly the foot, which was always cold. The patient could walk, but very slowly, and always dragged the affected side. If he wished to advance more quickly, he would take two steps with the left foot. He presented a pale, weak face and form; he was taciturn and timid, and cried easily. Wecke attended him for a year and six months, at the end of which he was radically cured."[1]

Traumatic Paralysis.—This paralysis, which follows surgical operations or accidents, when a nerve has been divided or compressed by tumors or effusion, etc., is very often met with. The extent of the paralysis is always proportionate to the injury. This can be determined by the rules laid down in a former chapter upon electric diagnosis.

It is hard to expect that any very remarkable results will follow our treatment in these cases. When the reparative process is complete, or nearly so, the muscle, or set of muscles, will begin to come under the influence of the current. In the case of a syphilitic or gouty effusion, the catalytic effect of the galvanic current will sometimes remove such an effusion and reëstablish conductivity of the vessels. Faradization at the time, when the nerve is restored (before the will can be brought to influence the muscular contraction), will prevent atrophy.

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[1] The author's translation of Ullsberger's Prize Essay, *American Journal of Obstetrics*, August and May, 1872.

Special Paralyses.—In *ptosis* following paralysis of the motor oculi, it is difficult to give great benefit, as it is almost impossible to reach this nerve. In the mean time, we must direct our treatment to the eye in a general manner, by the local *bain électrique*,[1] etc. There are several forms of paralysis of the muscles of the eye, that are nearly all due to specific tumors in the brain, or to rheumatic exudations, but sometimes come from over-exertion of this organ.

When these conditions are associated with facial paralysis, I have found that faradization of the seventh nerve would remove them. Benedikt holds out galvanization as the best form of electrization, in the treatment of these affections. He applies the positive pole to the forehead, and draws the negative one over the eyelid. He insists that the application should be short and feeble. Althaus recommends faradization.

Case of Traumatic Paralysis.[2]—"L., forty-three years old, dislocated his left humerus by falling on his left shoulder. He had pain in the shoulder, and found it impossible to use his arm, and that felt cold. The dislocation was found to be subcoracoid, and, after eight days, it was reduced. The pain ceased, but the paralysis continued. In the palm of the hand there was, after three weeks, considerable scaling of the epidermis. Pressure on the shoulder was not painful, but a strong grasp of the triceps and of the muscles of the forearm was unpleasant. Occasionally, there was a sense of formication from the middle of the arm down the extensor side of the forearm to the ends of the fingers. The left arm could be raised in a straight line forward about half a foot, but could not be carried backward nor across the breast. The forearm could not be bent on the arm, only the supinator longus was rendered tense. Extension was impossible; supination was slight. The hand could be raised somewhat. Abduction and adduction of the hand, flexion and extension of the fingers, were impossible. The prick of a needle was felt to the upper border of the lower third of the arm on both sides equally. In the lower third of the left arm, in the elbow-joint, and the upper part of the forearm, the skin is more sensitive on the right than the left. In the rest of the forearm, in the hand and fingers, the sensation is a little less on the left than right, but nearly equal. The muscles of the arm and forearm, of the hand and finger, as well as the deltoid, showed only the slightest reaction to the induction-current. Likewise, the use of a very strong galvanic current either to nerve or muscle, by opening or closing, failed to produce contraction.

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[1] Described in the chapter on electrodes.

[2] Reported by M. Bernhardt, *Berliner Klinische Wochenschrift*, No. 5, 1871.

"From the 5th of January, every other day the patient was treated with a strong galvanic current, the anode and the cathode being placed on the paralyzed muscles. After four weeks he could raise the arm forty degrees, also some distance backward, so as to touch the right shoulder with the left hand. Also, he could bend the forearm on the arm, and had some motion in the hand and fingers. After eight weeks more, motion was nearly restored."

II. "F.,[1] sixty years old, fell on the left shoulder. There was found sub-coracoid dislocation five days later. There was no power to move the arm at the shoulder, and only slight power over the forearm and hand. Numbness, with pricking, was felt in the forearm and hand. There was but little improvement under the galvanic treatment."

Facial Paralysis.—This disease, which may be produced by exposure, exudation, or pressure of the seventh cranial nerve in some bony canal by the product of inflammation, has its seat usually in the Fallopian canal. A syphilitic tumor in the cerebral substance may also make this pressure. In this case our treatment must be specific.

I have had very good results from the combined use of the two currents, using galvanism for the nerve, and applying it to the nerve itself, and to the chorda tympani, for the deafness that usually accompanies the disease, and the latter (faradization) to the muscles of the face. We may use it, as recommended in a previous chapter, one pole behind the angle of the jaw, and the other to the paralyzed muscle. When facial paralysis occurs with hemiplegia or locomotor ataxia, it is not wise to employ this treatment, unless the lesion is ancient. In facial paralysis from injury, galvanization is a better remedy than faradization. The following case is one in which this form of treatment was successful:

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[1] Case of M. Bernhardt (*Berliner Klinische Wochenschrift*, No. 5, 1871).

Wm. O. Ingraham, aged thirty, United States, boatman. Previous history: He has never been seriously ill, but ten years ago he had a chancre, followed by marked secondary symptoms. The only other ailment was a severe attack of rheumatism, occurring three years ago. This was undoubtedly a tertiary symptom.

His present difficulty began three months ago. At night he was disturbed by intense cephalic pains, dizziness, and disordered vision. For several days the pains were steady and most violent under either temple; he was also annoyed by post-aural pains. He then found that his hearing was becoming less acute, till the lesion finally occurred. This took place toward the latter part of July, 1870.

He awoke in the morning, and felt a pain in the head, attended by swelling and puffiness of the face. His attention was called by several of his associates to the "crookedness of his face." He looked in the glass, and saw the drooping of the left side of the face, with complete paralysis of the muscles at the corner of the mouth; then followed total loss of hearing. He could not appreciate the loudest noises when the sound ear was closed. The paralysis increased every day. A few days after this, the eyelid drooped, and he found it impossible to open or completely shut the eye. It became congested and irritated, and he experienced a burning sensation, with photophobia.

His condition grew gradually worse, till he was compelled to leave his employment, and seek medical aid. He never had had otorrhœa or ear-affections of any kind, nor had been paralyzed. His habits were good, and his hereditary history favorable.

When he applied to me, I found paralysis of the entire seventh nerve, motor ocularius, and disturbance of the sympathetic of the eye. There was no antagonistic force of the orbicularis oris, levator labii superioris et alæque nasi, or masseter muscles. He could hardly insert the finger in the mouth without pulling down the jaw with the other hand. He experienced a difficulty in mastication and deglutition, from involvement of the left side of the tongue, which, when protruded, inclined to the right side; with this there was indistinct articulation, and I was led to infer paralysis of the lingualis muscle.

From the patient's previous history I was led to suppose that syphilis was the primary cause of the trouble, and, from the depth of the lesion, that the seventh nerve was paralyzed at a point above its division.

From the specific features of his case I deemed the iodide of potassium to be the best remedy, and he was therefore put upon grs. v, thrice daily. Hypodermic injections of strychnia and morphia ($\frac{1}{64}$ of a grain of the former to $\frac{1}{32}$ of the latter) did much good in relieving the severe cephalalgia. Localized galvanization was resorted to, and both the primary and secondary currents used. After the nerve and its branches had been pencilled over with stick-caustic, one electrode was applied to the ramifications of the nerve, while the other was placed over the mastoid process. So successful was this treatment that, after a daily *séance* lasting twenty minutes, in three weeks the patient's face was much more symmetrical, and the act of mastication was improved.

The pains likewise disappeared under the same current. Occasional directions of this and the faradic current over the eyelid did much toward the improvement of sight.

It now occurred to me that Matteucci's experiment upon the ear might be followed by gratifying results; so its cavity was filled with water, and one of the battery-wires finely covered with sponge was gently introduced into the external meatus. After four weeks his hearing was so markedly improved that he easily distinguished loud voices, when the sound ear was closed.

November 12*th* (seven weeks after commencement of treatment).—During the application of the current the face resumed its expression, and he was able to close his eye completely. He is greatly improved. Injections discontinued. He has almost complete control over the levator palpebræ—this is more marked in the morning—articulation good.

November 28th.—Has now taken the battery for nearly ten weeks, and is about to discontinue treatment. The face is perfectly symmetrical, and the hearing nearly as perfect as ever—the only remaining disfigurement is a slight drooping of the eyelid on the affected side. Appetite good, and, though emaciated at first, he has now completely regained his former good condition.

In this case the cause was evidently syphilitic; but, though the central lesion was cured by iodide of potash, I can clearly lay the restoration of the paralyzed nerve to galvanism and faradization.

Althaus[1] reports the following case, where the disease followed exposure:

"Wm. F., a barrister, aged thirty-five, having been exposed to a draught of cold air at a railway-station, became affected with paralysis of the left portio dura. The physiognomical expression had entirely vanished from that side of the face. The patient was not able to laugh, frown, whistle, or shut his eye, which latter appeared staring and protruded. The angle of the mouth was depressed, and drawn toward the opposite side; that of the sound side being higher, and drawn toward the ear. The cheek was flabby and loose, and eating and speaking were troublesome. The patient was sent to me by Dr. Todd, whom he had consulted six months after the commencement of the affection. Farado-muscular contractility was diminished. I directed the faradic stimulus to all the paralyzed muscles individually, with the effect that the patient regained his normal physiognomical expression after a fortnight's treatment."

Captain T. D., aged forty-three, born in Ireland. On awakening one morning in July, he found something strange about his face, but did not realize at that time what it was; his friends told him, however, and he discovered that it was twisted to the left side. He applied at the New York State Hospital for Diseases of the Nervous System four days afterward, when he presented all the symptoms of facial paralysis. Dr. T. M. B. Cross, under whose charge he was, treated him with galvanism, both the primary and induced currents. In the course of a week he acquired the power of closing his right eye voluntarily. He took strychnia and phosphoric acid internally. After about twenty applications of galvanism, he was dismissed, with the power almost entirely restored to all the paralyzed muscles. He is now well, with the exception of slight paresis of the orbicularis-oris muscle. At first the induced current did not act, whereas the galvanic did from the very beginning.

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[1] "Medical Electricity," p. 500.

These two cases are identical in many respects, and may be considered good representative types of those usually met with.

Reflex Paralysis.—This form commonly follows wounds, injuries, or other causes of irritation, and is due to the irritation transmitted from the peripheral end of a nerve to the cord. It does not always disappear with the cause. Galvanism to the seat of irritation will relieve the condition.

Paralysis of the Bladder.—Paralysis of the bladder occurs from three causes, viz.:

1. Interruption of communication between the bladder and the cerebrum.
2. Diseases of the lower part of the cord.
3. An alteration of the excitability of the bladder without cerebral disease.

The galvanic current is the best for the purpose of electrizing the bladder, and the results are brilliant and satisfactory. Faradization may, however, be used advantageously, particularly in cases of atony. In the dribbling of children it is of great service. Some authors condemn galvanization of the bladder, on the ground that it produces an electrolyzation of the urine. It may be well to empty the bladder and refill it with water before applying the current.

Rheumatic Paralysis.—We obtain the most cheering results from the use of electricity in this common malady. The localities usually affected are the extensor muscles of the forearm, which are supplied by the radial nerve, the muscles of the eyes, the deltoid, and trapezius muscles, and the small muscles of the hands. These latter rapidly atrophy, if the paralysis is not treated at once. The electric irritability of these muscles is nearly always greatly heightened. Faradization is the best variety of electricity for this disease, and in nearly every case it is successful.

I. Thomas H., aged thirty, had a severe attack of acute rheumatism before he presented himself to me. He had been a sailor, and constantly exposed to rain and cold. After his disease, for which he received but little treatment on shipboard, he resumed his duties. He found, a week subsequently, that his arm was without sensation, and that he could not use his hands as he had been in the habit of doing.

When he left his ship, I saw him, and found considerable atrophy of the muscles of the forearm, and great loss of cutaneous sensibility. The patient was treated for a little less than a month, and the recovery was complete.[1]

II. *Case reported by Althaus.*[2]—"Mrs. G., aged fifty-one, was sent to me by Dr. Hyde Salter, in January, 1862. Three months before, she had suffered from a severe attack of rheumatic fever, nearly all the joints having been affected. As soon as she was able to move about again, she went into the country, where her general health much improved. Her right arm and hand, however, remained painful and useless, and she was therefore advised to try faradization. On examining the forearm and the hand with the æsthesiometer, I found that the sense of touch was considerably impaired. Moreover, the muscles were considerably wasted, more especially the flexors and the interossei and lumbricals; and, on applying the faradic current to these muscles individually, it appeared that their sensibility, as well as their contractile power, was very nearly gone. The hand had lost its natural shape, and resembled a bird's claw—a configuration of the hand which is always associated with loss of power in the interossei and lumbrical muscles, and renders it entirely useless. The pain was greatest at night, and chiefly felt in the fingers. The general health of the patient was tolerably good, but she was very thin, and suffered greatly from despondency. I used faradization of the skin for the cure of the pain, and of the suffering muscles for restoring them to their normal nutrition and function. After two operations, the motor power of the fingers was much increased: the muscles responded more readily to the faradic stimulus, and the æsthesiometer showed an improvement in the sense of touch. The pain, although not entirely gone, was much diminished. After a fortnight's treatment (the patient attended every other day) she was able to cut her own meat, and to do some housework, and in a month she could do needle-work for three hours consecutively without feeling pain or fatigue. There was then no longer any difference in the sense of touch in the right and left arms, the bulk of the muscles was much increased, and the hand had resumed its normal shape. This result was all the more satisfactory, as the age and general weakness of the patient were not in favor of a rapid cure."

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[1] I found none of the hyperæsthesia that Duchenne mentions.

[2] Althaus, p. 481.

Dysphonia and Aphonia.—Both of these affections occur with partial or complete paralysis of the vocal cords. Whether resulting from diphtheritis or typhoid fever, over-exertion from prolonged use of the voice, terror, anæmia, or the results of metallic poisoning, they are amenable to faradization. Not so, however, are they when produced by the pressure of an aneurism, tumor, or of local morbid growths. Dr. Mackenzie, of London, has devoted himself to the treatment of these diseases, and his instruments are those we most use. The faradic current is that recommended. Dr. Mackenzie faradizes the glottis, and, of two hundred cases treated by him, but four were unsuccessful. Dr. George Johnson, in the *Medical Times and Gazette*, January 15, 1870, p. 61, relates a case of aphonia he treated with faradization; its history is briefly as follows:

"A boy, about twelve years of age, was much frightened, and nearly drowned, by falling into a pond. From that time he completely lost his voice, his intellect being unimpaired. When I saw him he had not uttered an audible sound for two years. I saw that his larynx was healthy, and I determined to apply electricity. The first shock elicited a loud scream, and at once he recovered his speech."

In most cases it is necessary to apply the electricity again and again before the cure is complete, and in some cases the treatment is unsuccessful, but these are comparatively rare. When the general health is impaired, treatment should be directed to remedy this, while the electricity is being employed.

Faradization has also been employed in *glosso-labio-pharyngeal paralysis*, but usually without success. Dr. Gottner,[1] in spite of this fact, reports a case of pharyngeal paralysis successfully treated by galvanization of the sympathetic. In a very short time the patient was able to swallow with ease. This was at about the forty-fourth day of the disease: after three applications the cure was completed."

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[1] *Gazette Médicale*, Stat. April 20, 1872.

Progressive Locomotor Ataxia (*Sclerosis*).—Onimus has used galvanism in this disease with success. His plan is, to make application to the cord by the inverse current. This treatment can only afford temporary relief, and so far as I can ascertain there are but two cases where cures were effected, and these are reported by Benedikt, and Dr. Foot, of Dublin. The disease, when not due to acute disease of the cord, but to the influence of such maladies as diphtheritis, may yield to galvano-therapy, as Dr. Foot's did. True sclerosis of the cord, however, is not amenable to treatment of this kind alone. Galvanism here can only be employed as an adjuvant. Dr. Hammond advises the constant current, of high tension. This should be applied to the spine.

Progressive Muscular Atrophy.—Those cases of wasting paralysis having the above name depend upon a wasting of certain muscles or groups of muscles from extreme steady use and over-exertion. The affected muscles respond well to the current, as they are unchanged in point of contractility. Faradization will prevent the advance of the disease, and retard atrophy. Mr. Fagge reports the following case:[1]

"G. P. H., aged twenty-seven, admitted into clinical ward, under my care, June 12, 1867. He is a harness-maker. About eight weeks ago he began to feel weakness in his arms, and became unable to grasp firmly with his hands. He also had tingling sensations in his arms. The muscles of the forearms, except the supinator longus, were considerably atrophied; and the interossei, and other muscles of the hand, were also much wasted. The movements of the hands were very imperfect; for instance, he had great difficulty in unbuttoning his shirt. Tremor was not present in any marked degree; I think I observed it slightly in one of the muscles of the left forearm. On testing the muscles with the continuous current, it was found that thirty-five to forty cells were required to produce contractions in the extensors of the forearm; whereas the biceps reacted to twenty cells. The medicine which was prescribed for him, besides an occasional purgative, was a mixture containing three grains of iodide of potassium, which he took three times a day for seven days, when it was discontinued, in order that the value of the electrical treatment might be more surely tested. This treatment consisted in the application of the continuous current to the spine (according to Remak's method) every day, for fifteen minutes at a time. It produced a strong galvanic taste, and a tingling sensation in the right arm (the electrode was applied beneath the right auricle). The forearms were wrapped in cotton-wool, and placed upon splints. After seven days of the treatment the splints were removed, and it was then found that there was decidedly more power in the grasp. At the end of sixteen days he could dress himself with ease, and could write tolerably well. He could not bear so strong a current as at first; twenty-five cells now produced distinct contractions in the arms and legs simultaneously. The muscles were fast regaining their firmness and tone. He continued to improve. On August 22d, it is noted that he could write several letters in a day. He went out nearly well, on September 21, 1867. I have since heard (October, 1868) that he has remained free from any further symptoms of the disease. Besides the affection of the arms, this man had likewise weakness of the lower limbs; from this he recovered at the same time."

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[1] *London Practitioner*, December, 1868.

Many of these cases have been treated at the New York State Hospital for Diseases of the Nervous System. The galvanic current produced marked restoration of the muscle.

Benedikt[1] reports a case, the interest of which lies in the fact that the shoulder-muscles were those affected, that there was extensive vaso-motor paralysis in the face, neck, and shoulder-blade, which quickly disappeared on galvanization of the cervical sympathetic.

The reaction on opening the current with a gradually-increasing current at the anode became weaker or disappeared, to reappear again when the current became stronger.

Locomotor Ataxy subsequent to Diphtheria—Recovery.[2]—

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[1] *Wiener Medical Presse*, 1872, p. 9.

[2] Reported by Dr. A. W. Foot, in *Dublin Journal of Medical Science*, September, 1872, p. 176.

"A private servant (coachman), aged thirty-one, height five feet ten inches and a half, weight ten stone six pounds, married, and father of children, was admitted into hospital March 22, 1872, and put under the care of Dr. Charles A. McMunn. The circumstances which immediately led to his coming into hospital were as follows: His mistress, observing with regret that the man appeared, from the unsteadiness of his gait, to be frequently under the influence of drink, asked the medical attendant of the family to advise her what to do about him. The doctor sent his son to see the man, and he reported that the man did not drink, but was, in his opinion, suffering from some spinal affection, and recommended him to be sent to hospital at once; this was accordingly done. When the history of the case came to be investigated, it was ascertained that the man got a severe wetting at the Fairyhouse races, April 10, 1871, which resulted in "a heavy cold" and "sore-throat," which sore throat was followed by dysphagia and regurgitation of fluids through the nostrils; his food used also to "go the wrong way," and cause coughing. These symptoms occurred a fortnight after the "cold," and when he considered himself cured of it. An habitual perspiration of the feet and ankles became suppressed at this time, and had since remained so. For the next ten months or so he considered himself quite well; but, when the proper inquiries had been made, it came out that within that time he had observed a marked diminution in sexual power; also, that in descending stairs or steps his feet "were inclined to give way," and he often tripped, slipped, or missed his footing; sometimes, also, when attending at table, he tramped heavily in walking about the dining-room, and was unusually awkward in holding or handling plates or dishes; he also for some time suffered from amblyopia. So far, he had been able to perform his duties as coachman very well, frequently driving four-in-hand; but, three weeks before admission, he got another heavy wetting, not, however, followed by 'cold." A week afterward he was on a ladder outside the house, cleaning windows, at a considerable height from the ground, when, feeling giddy, he got off the ladder and went into one of the rooms, where he fell on the floor; after that he got a "numbness" in both hands, and could not "feel things rightly with them;" he became hardly able to write, the pen slipping away from between his fingers because he could not hold it.

When examined upon admission, his heart was free from apparent disease, and its action not slower than usual, but evidence of weak circulation was present in his very purple hands and feet, which in cold weather, and when he has been at rest for some time, became quite livid. He walked in a staggering and unsteady manner, could not run, jump, or hop, although he used to be very active on his feet, and had won a flat-race of one hundred and fifty yards before the "cold" in 1871. He had noticed his power of running to fail during the present year, and had observed that such exercise put him out of breath, and brought on palpitations. He could not get out of bed in the dark, nor stand steadily with his feet together, toe to toe, in the ataxy position, with his eyes shut, because, as he said, "the ground goes from under him," or "gives way under him;" he feels "as if he was on a spring," or "on soft turf," or "on a feather-bed." None of these similes were in any way suggested to him, nor were any leading questions used to elicit the information sought for. When he stood with his feet apart, and was supported on either side, the ground felt quite steady under him. A numbness extended over the feet, and to a short distance above either ankle, occupying the tract which had been the situation of the habitual sweating, now almost a year suppressed. Both his hands were "numb," the left more so, and he was awkward and slow in execution of such digital movements as buttoning, writing, picking, and holding. The numbness was principally on the backs of the hands, and did not extend above the wrists. The æsthesiometer showed the deficiency in the sense of touch to be greater on the dorsal aspect of the right hand than of the left; the two points were first appreciated at one inch five lines, in the axis of the limb, on the former, and at one inch on the latter. The mean power of the right hand was 40.66 kilos.; of the left, 52.00 kilos. This sinistral preëminence he accounted for by his having "a strong left hand," from the constant pull on that hand in driving; much of it, however, was due to actual deficiency in the right hand, as was afterward shown by its restoration. He has muscular twitchings in both hands and legs, no pains or cramps except a painful feeling of weakness across the back of the left hand, in the line of the metacarpo-phalangeal articulations. He had some difficulty in guiding food on his fork to his mouth, could not put the index-finger of his right hand to the tip of his nose with the eyes shut, either quickly or with certainty of aim; he misses the mark at the first offer, but can hit it off better with the left forefinger. Sense of touch impaired in the left hand, sensibility to temperature normal in both. His articulation had become affected within the three days prior to his admission; he spoke with a hesitation, clipping his words; he thinks his tongue and lips are swollen, and that this is the reason he "speaks thick;" the tongue deviated slightly to the right side when protruded; there was no obliquity of the uvula, or dropping of the soft palate; the pillars of the fauces were a little redder than natural; no alteration in tone of voice; he could pronounce all the vowels distinctly. The right pupil was larger than the left one, which was of normal size; it responded to light, but was sluggish in its movements. With the ophthalmoscope, the margins of the disk in the left eye were ill-defined, the disk congested, and the veins very tortuous; sight in both unaffected—no ptosis, strabismus, diplopia, or congestion of the conjunctiva. The functions of the bladder and rectum were undisturbed; there was no constipation, nor belt-like sensation round the body, nor albumen in the urine. Pain "in the small of the back" was complained of; its anatomical locus was found to correspond with the spinous process of the first lumbar vertebra.

Treatment and Progress.—At first the case was regarded as one of structural rather than functional disturbance of the spinal cord, as the history was not fully investigated, nor the clew of the remote attack of diphtheria traced until he had been some days in hospital. Meanwhile he was ordered fifteen-drop doses, three times a day, of liquid extract of ergot of rye, because I had observed the good results of this medicine in congested conditions of the cord.

March 25th.—A galvanic current from thirty cells of a Smee's battery was passed along the back for fifteen minutes, with moistened conductors, the positive pole was applied over the fifth cervical vertebra, the negative moved about over the lumbar vertebra; this current was not felt, nor did the conductors redden the skin.

26th.—He remarked that he 'had more power in his hands.'

28th.—Can stand more steadily with his eyes shut. The lumbar pain is gone. A current of fifty cells was used in the same manner as before. He scarcely felt the negative pole, and it only slightly reddened the skin.

29th.—He finds he 'can write much better.' Stands more steadily. Current of fifty cells used. The same strength of current applied in the same manner to the previous case of locomotor ataxy was quite unbearable, thirty cells being the most he could at any time bear, although a much larger and more muscular man.

30th.—His friends remark upon his improved appearance. Current of forty cells used.

31st.—The habitual perspiration in the feet reappeared for the first time.

April 1st.—The ergot was discontinued, and $\frac{1}{64}$ grain of strychnia ordered twice a day. Galvanism to the spine continued.

2d.—Able to put his food into his mouth with his left hand. An analysis of his urine was made to-day. Urine of April 1st and 2d (twenty-four hours) = 34 fl. oz. acid; spec. grav. (filtered) 1,027; turbid from abundance of pale urates; no albumen; urea 31 grs. per 1,000 grs. urine, or total quantity = 461½ grains; phosphoric acid 3.48 grs. per 1,000 grs. urine, or total quantity = 51.76 grains.

4th.—Able to take a walk of eight miles without fatigue. While out, he tried to run, but one foot got in front of the other and threw him down.

7th.—Can button and unbutton his clothes without looking at them.

9th.—Can feel any small thing, such as gravel, under his feet with his boots on.

15th.—Fifteen-drop doses of the tincture of perchloride of iron ordered three times a day, in addition to his strychnia.

16th.—The numbness has quite left his hand; he can balance himself on his toes; the habitual perspiration of the feet is quite reëstablished.

19th.—Went back to his situation for the day, in order to drive the carriage; a pair of horses being required for a particular occasion, which he was afraid to trust with the man who was acting for him in his absence. He was able to manage the horses very well.

23d.—His weight is found to have increased seven pounds since his admission; he is now ten stone thirteen pounds. The dynamometer indicates with the right hand 59.66 kilogrammes, with the left, 53.33 kilogrammes; showing an increase of power in the right hand of 19 kilogrammes, and in the left of 1.33 kilogramme.

25th.—He returned to his situation; a slight hesitation and clipping of his words remained, which I thought would be likely to disappear more quickly under the influence of country air and sea-bathing, both of which were at his command, than under any form of treatment in hospital. I have since heard that he is 'as well as ever.'

Without claiming any active curative effect for galvanism in this case, it is proper to observe that he became more sensitive to it as his health improved, and that he expressed himself as 'refreshed after it as if he had had a bath.' It was used daily during his stay in hospital, and for fifteen minutes at a time; the number of cells employed varied from thirty to fifty. The current was always applied to the spine with moist conductors; the positive pole placed in the cervical region, the negative pole over the lumbar vertebræ. The dilatation of the right pupil first directed my attention to the possibility of a diphtheritic origin of his symptoms, as the opposite condition of the pupil is that most frequently observed in true locomotor ataxy."

CHAPTER IX.

HYPERÆSTHESIA, ETC.

Neuralgia.—Its varieties.—Etiology.—Facial Neuralgia.—Cervico-brachial Neuralgia.—Intercostal Neuralgia.—Gastrodynia.—Tic-Musculaire.—Sciatica.—Rheumatism.—Anæsthesia.—Anæsthesia of the Sensory Organs.—Asphyxia, etc.

By the term *hyperæsthesia*, we mean an exalted state of sensibility in the nerve itself, dependent upon some change between its point of origin and periphery. It does not necessarily depend upon inflammation of the nerve, for the pain of hyperæsthesia is different from that of inflammation.

Neuralgia.—The seat of pain may be either superficial or deep. In the former case, the terminal twigs of the nerves are the parts affected, but in the latter form we must look for the lesion in the nerve-trunks or cerebro-spinal axis. Any cause that will congest the sheath of the nerve may produce neuralgia. Pressure is a frequent cause, and usually comes from the products of inflammation in bony canals, or at the point of emergence of a nerve from some foramen. Spiculæ of bone, tumors, and deposits, will create the same disturbance.

Oftentimes the disease is purely functional. With the production of neuralgia by inflammation of certain organs, and when large nervous trunks are affected, the disease is obstinate and not always curable. The selection of the current has been a serious stumbling-block. Probably the opinion of Dr. Anstie is worth more to us, from his faithful pursuit of this specialty, and careful observation, than any other.

Dr. Anstie observes:[1] "The constant current is a remedy for neuralgia unapproached in power by any other, except blistering and hypodermic morphia, and the latter is often surpassed by it in the permanence of its effects, while it is applicable in not a few cases where blistering would be useless." Dr. Anstie condemns faradization. In the main, I have found it without effect in most cases; it has served me well, however, in those cases of superficial hyperæsthesia attended by a certain sluggishness of the circulation. Here I have used it with the dry excitors or *brousse*, and have been successful.

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[1] "Neuralgia," etc., p. 200.

Benedikt insists that the application should be made to the point of disease. As the posterior nerve-root is essentially the seat in deeply-located neuralgias, we should endeavor to bring this particular part within the circuit. In cases of brachiocervical neuralgia that have come under my care, I have found that, when the pole was applied over the brachial plexus, the result was better than when the nerves were directly electrized.

Althaus recommends that the positive pole should be invariably applied to the painful point, and still further shows that the negative pole would produce an excitement that would increase the severity of the pain. Dr. Russell Reynolds thinks that there is no appreciable difference in the direction of the current as far as its good effects are concerned, whether it be direct or inverse. I have found, in many of my cases, that, when the inverse current was used, the severity of the shock aggravated the pain notably. I found this particularly in a case of facial neuralgia, that had existed for years. The direct current ameliorated this condition of the patient, while the inverse acted contrariwise.

My best results have been obtained from a use of the constant current continuously applied for from five to ten minutes. I vary the position of the poles where the pain is concentrated at some point. The current should not be so strong as to produce burning or pain. It should cause simply a tingling sensation, with slight redness under the negative pole. The application should be made at least three times a week, or daily, if possible. A large sponge-covered electrode may be employed, or, if concentrated local action is desired, either Duchenne's points or a small cylindrical sponge-electrode may be made use of.

Altogether, the form of neuralgia most generally met with is *facial neuralgia.* This may depend upon a number of causes; perhaps malarious influences or exposure to cold, or in some cases a carious tooth is the origin of the neuralgia. Mental excitement and functional disorders are also frequent causes, and in most cases the disease may be traced to them when women are the sufferers. There is another form of neuralgia which is a concomitant of old age. Galvanism is of use in all these cases. In the former varieties, faradism is indicated sometimes. There are many obstinate cases that come under the head of *epileptiform neuralgia.* They require a most persistent course of galvanization. The latter is preferable to division of the nerve, for, according to Althaus, it alters the nutrition of the affected part. It is well to make the application of one pole to the supra-orbital point of emergence when this nerve is affected, and this should be the positive pole.

In the treatment of painful diseases of the nerves, we should differentiate between neuritis and neuralgia. This may be done by the galvanic current. Patients suffering with neuritis can hardly bear the same strength of current which would soothe and relieve a neuralgic condition. In neuritis, then, the application should be short, and the current of low tension. Mild cases of *headache* may be cured by faradization of the face by a soft sponge, or the "electric hand."

Cervico-brachial neuralgia is a persistent variety of neuralgia that often resists all forms of treatment. The continuous current is competent, however, to effect a rapid amelioration. One pole may be held over the brachial plexus, and the other applied to the course of the nerve by means of a fine-pointed sponge-electrode. I have found hypodermic injections of atropia to hasten recovery wonderfully.

Intercostal neuralgia, *gastrodynia*, and *pleurodynia*, all yield most rapidly to both the currents. In the latter, the positive pole is to be applied to the solar plexus. In pleurodynia and intercostal neuralgia, we may use Duchenne's method or plan—one pole on the nape of the neck, and the other to the painful spot. My friend Dr. Roger Tracy gives me the particulars of his treatment of a young girl for pleurodynia. She had been put upon courses of iron, strychnia, and belladonna-plaster, but all failed to relieve her; finally he used the faradic current as recommended above, the negative pole being placed upon the painful part, and the positive to the nape of the neck. One application removed all pain, and at her next visit she said that she had had no return.

Tic Musculaire.—All neuralgic or inflammatory conditions of muscles are readily amenable to faradization, and the most painful twinges will often disappear after fifteen minutes' use of the current.

Sciatica.—Probably one of the most obstinate diseases we have to contend with is this neuralgic disease of the sciatic nerve. Usually it results from some deep-seated inflammation or derangement of one or more of the pelvic organs; in this case it is reflex; at other times rheumatism or an inflammation of the loose tissue that surrounds the nerves will produce the disease, or it may even occur with paralysis. In our treatment we must be guided by these conditions. The exciting cause is to be treated by other remedies than galvanism. Many weeks are usually required to perform a cure, and, during this time, we must persistently use the continuous current applied over the track of the nerve by means of conical sponge-covered electrodes. In the severer form of sciatica, as well as neuralgia, there is often an anæsthesia of the skin, with coldness. If the arm or leg is carefully kept in cotton-batting during the intervals between the *séances*, the patient will be greatly relieved.

I. *Cervico-brachial Neuralgia.*—Mrs. G. consulted me in June for cervico-brachial neuralgia. This patient had been affected with the disease for many years. So exquisitely hyperæsthetic was the entire arm, that she could hardly bear the weight of her dress. If her fingers were touched roughly, a most excruciating twinge of the entire median nerve would follow. She was deprived of sleep by excessive pain, and had become anæmic and emaciated. Iron and strychnia, and the various narcotics, had given her no relief. The application of the moderately strong faradic current aggravated the pain, but a reduction in the force of the current soothed and lulled it. I applied the galvanic current (descending current) by means of wet sponges. The first application of fifteen minutes, with twenty cells, gave her almost instantaneous relief. *Séances*, every other day, in less than three months effected a permanent cure.

II. *Facial Neuralgia.*—Dr. Joseph Stead,[1] of Manchester, reports the following case of facial neuralgia: "The patient was a girl of twenty-four, and had been suffering from facial neuralgia of both sides for three months. For two nights previous to her visit to me, she had been compelled to get up from bed and come down-stairs and spend the night awake and in great agony. Five minutes' application cured one side of the face, and a second five minutes' application cured the other, and then, to my surprise, she fell fast asleep in her chair. There has not been the slightest return of pain."

III. *Neuralgia of the Fifth Nerve.*—G. E. The patient had been suffering for several years with neuralgia of the fifth nerve, of the most severe form. He had been subject to malarial fever, and, after a protracted siege of the same, was seized with neuralgia, which would recur at intervals. At these times he found it impossible to sleep. He became weak and nervous, and, when I saw him, his irritability was pitiful. The *materia medica* had been wellnigh exhausted in his treatment—opium and quinine being the chief medicines that he had taken. When he came under my charge, I made him discard all of these, and put him simply upon the Solution Hammondi[2] (the hospital mixture at the New York State Hospital for Diseases of the Nervous System). I applied the continuous current regularly every day for some three weeks, when I was gratified in seeing my patient so nearly well that I entirely discontinued treatment. His general health returned, and the use of the medicine was suspended. The neuralgia was confined chiefly to the supra-orbital branch of the fifth nerve, and to this nerve I applied the current.

IV. Dr. William Stephenson, of Edinburgh,[3] relates the following case of sciatica: David O., aged fifty, a letter-carrier, has suffered from sciatica for four months, never had rheumatism, but once lumbago. The pain extends over the whole length of the nerve, and affects also the superficial sacral nerves; it is always worse at night, and greatly interferes with sleep. He has been blistered seven times, four times had acupuncture been applied, and he had taken several medicines. From the acupuncture he derived some benefit, but the pain always returned.

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[1] *Medical Press and Circular*, November 1, 1871, p. 384.

[2] ℞.—Strychnia sulph. gr. i.
Ferri pyrophos.
Quin. sulph. } āā ʒ i.
Syr. zingib.
Acidi phos. dil. } āā ℥ ij.
Misce—ʒ i. t. i. d.

[3] *Medical Press.*

The electricity (continuous current) was applied, and, benefiting from the experience of a former case, electro-puncture was tried at once. The relief, after the third application, was decided, but the returns of the pain after walking were at first severe and frequent, but never lasting long. Whatever pain he had was always at once removed by the application. In a fortnight he could walk about freely, but it was not till after five weeks' use that the last residue was removed, and he was able to resume his employment.

Dr. Mierques (*Lyon Médicale*) applies, in gastralgia, a plate of zinc on the epigastrium, under which there is placed a piece of linen moistened with vinegar and water, and similar disks of copper between the shoulders. These are united by a conducting wire, and kept on by a bandage. These are useful, he says, in neuralgia, and cramps of the lower extremities, etc.

V. *Sciatica.*—Mr. J. W. S. After constant exposure during the war, the patient contracted a low typhoid fever, which left him weak and emaciated for a long time. Since 1868 he has had twinges of pain down the back part of the leg, which have kept him in a perpetual state of misery, with only occasional intervals of several months, when he is free from pain. In winter his trouble is worse, and any exposure will immediately produce a severe attack of neuralgic pain. Any indiscretion in his diet will also be followed by sciatica. He had gone through the usual siege of medication, including morphine, hypodermics, and stimulating lotions. He came to me in July, when I made applications of galvanism to the nerve by the conical sponge-electrode, the sponge being held firmly over the obturator foramen. At the first visit his pain was excessive, but after fifteen minutes' application he left, feeling a sense of relief which he had not known for months. Two months and a half of this treatment were sufficient to dispel the pain, which did not recur. Four months afterward, he made a visit, when he stated that he had not had any return.

Rheumatism.—The use of electricity in this disease is attended with the following results:

1. Diminution of pain.
2. Absorption of exudation.

Rheumatism is due to a retention of secretion dependent upon a cold or damp condition of the atmosphere. It finds a powerful remedy in electricity. By it, the contractile walls of the blood-vessels and lymphatics are stimulated, and the pent-up secretions are carried off. The faradic current has a remarkable anæsthetic effect in these cases.

Dr. Holland, of Louisville, reports the following:[1] Mrs. M. C., aged sixty, had suffered about ten days from a rheumatic inflammation, with some exudation in the right wrist, rendering the joint immovable; there was one point upon the dorsal surface especially prominent, hard, and marked by excessive pain. The phalanges were semiflexed and stiff, probably from effusion around the tendons. Stimulating liniments and lotions, conjoined with regulated diet, had been used without making the faintest impression upon the disease. In one sitting the pain and tenderness were greatly relieved, and by local faradization of the muscles in the forearm almost entire freedom of movement in the phalanges, with partial but very evident benefit to the carpal mobility, was produced. The sittings were held on alternate days, and after the third, as none of the symptoms remained but a slight swelling, the case was dismissed. She shook hands unconstrainedly with me, a few days since, and reported the joint as well.

Anæsthesia.—Anæsthesia implies a full or partial loss of sensation dependent upon cerebral or spinal disease, or commonly upon a derangement of the peripheral nerves. Anæsthesia may be caused by disordered states of the blood, or hysteria. Various mental causes will produce the disease, as will bodily fatigue. Sometimes the disease is due to central causes, when the loss of sensation is about the same. With anæsthesia there is a loss of tactile sensibility, "pricking," etc., and sometimes sensation is abolished entirely. According to Eulenberg, the different functions of the cutaneous nerves of sensation (touch, general sensibility of the skin, sensibility to pain) may be suspended singly or together, and paralysis of one function may occur with increased energy of others. Pressure, sense of heat, and sense of locality, are paralyzed with the sense of touch partially or together. With anæsthesia there is disturbance of nutrition and circulation due to paralysis of the vaso-motor and trophic nerve-fibres. In making our diagnosis, we may use the æsthesiometer. In hysterical anæsthesia it is often impossible to give relief by electricity. The current should be the faradic, with the metallic plates or *brousse électrique.* Very often the disease will occur with a loss of smell or disturbance of vision (amaurosis), nervous deafness, loss of taste, etc. These should be treated by the galvanic current after the several ways already enumerated. Anæsthesia of the fifth pair is a disease that is frequently met with. The phenomena occurring with the different varieties of the disease may be thus tabulated:

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[1] *American Practitioner*, July, 1872.

When the ophthalmic branch is involved.	Anæsthesia of upper eyelid or forehead.
	Irritating substances entering the eye are not felt.
When the superior maxillary branch is involved.	Anæsthesia of the skin of the upper part of the face.
	Teeth of the upper jaw are insensible.
When the inferior maxillary branch is involved.	Anæsthesia of skin of the lower part of the face.
	Increased flow of saliva.
	Mastication difficult.
	Teeth of the lower jaw insensible.

The disease may be complete. The galvanic current of low tension to the nerve, and mild faradization of the skin, are recommended.

Dr. Moos [1] reports a case of nervous deafness he cured:

"In the course of a developing series of nervous phenomena, there appeared first hyperæsthesia of the auditory nerve, and subsequently complete deafness; this, by means of a prolonged treatment with the uninterrupted current, gradually disappeared."

Asphyxia, Suspended Animation, etc.[2]—Dunglison defines asphyxia as "a state depending upon an insufficient aëration of the carbonized or venous blood. Owing to the supply of air being cut off, the unchanged venous blood of the pulmonary artery passes into the minute radicles of the pulmonary veins; but, their peculiar excitability requiring arterial blood to excite them more or less, stagnation takes place in the pulmonary capillaries, and death occurs chiefly from this cause and from the want of arterial blood, and not owing to venous blood being distributed through the system and poisoning it, as was the idea of Bichat."

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[1] Heidelb. Bu., v., 82–84.

[2] For the history of numerous experiments with this agent, the reader is referred to an article by the author in the *American Practitioner*, October, 1872, p. 193.

The causes of asphyxia may be submersion in a medium unfit for respiration, or drowning; pressure of the glottis, or strangulation; paralysis, from traumatic causes, of the muscles of respiration; and suffocation when air is denied the lungs, either by stoppage of the air-passages or the inspiration of poisonous gases; or, finally, the asphyxia of new-born infants, or *asphyxia neonatorum*.

The different ways productive of asphyxia, recited before, all cause the same symptoms to be manifested, and a general paralysis of the system ensues. The lungs are powerless to do their work, as they are filled with carbonic-acid gas, which cannot escape. Electricity exerts its restorative power by exciting nervous force. This may act secondarily by stimulating the paralyzed nerves and by emptying the minute blood-vessels, or it may act directly upon the heart and the vaso-motor nerves through the sympathetic, or immediately upon the nerves supplying the special muscles concerned in respiration (the phrenic and intercostals). It may expel the blood from the minute vessels of the cord, or diminish a congested condition of the cerebrum or cerebellum.

Experiments made by Meyer demonstrate the fact that after the death of an animal, when the heart no longer beats, if a strong induced current is transmitted into this organ, its rhythmical contractions reappear. The contractions are much more manifest in the right portion of the heart than in the left, as generally after death the left ventricle is firmly contracted, and is not reached by the electric irritation, while the right ventricle in this condition is almost always filled with blood, and contracts powerfully under the influence of the electrical current.

In animals that have been killed by chloroform the left ventricle sometimes continues to pulsate, though faintly, after the action of the right ventricle has ceased, in consequence of excessive expansion by means of the black blood. If in such cases we electrize the left ventricle, its pulsations begin again and the expansion lessens. The insensibility following the inhalation of carbonic-acid gas, as well as other noxious vapors, and other forms of asphyxia, are finally produced by coma. The use of galvanism should therefore be directed to the cerebral as well as pulmonary difficulty.

There are certain conditions separate from asphyxia, resulting in death. These are strictly cerebral as far as the primary lesion is concerned, and may be enumerated as concussion, congestion of the brain, and narcotic poisoning. Syncope is a morbid condition, in which electricity, as I have stated, may be advantageously used. In sunstroke the galvanic current has enabled me to save at least one patient, and I do not doubt its power to do good for others.

In the consideration of poisoning by both narcotics and sedatives we must realize the fact that narcotics produce death, beginning by coma and finally ending in asphyxia, and direct our treatment to both centres, the brain and respiratory organs; and that sedatives produce death by syncope, and here direct our energies to the stimulation of the heart. In concussion, it is our idea to diminish the disturbance of the brain, and reëstablish the normal circulation.

In the production of respiratory movement, it has been found by M. Grondet[1] that the excitation of the diaphragm through the phrenic nerve is the most desirable way. To electrize this nerve we find the anterior border of the scalenus-anticus muscle by pulling the skin inward, with two fingers placed on the outer border of the sterno-cleido-mastoideus. Without discontinuing the action of the fingers, we separate them sufficiently to introduce between them a narrow moist conductor, which then presses directly on the phrenic nerve. After we have done the same thing to the other side we allow the induction apparatus to work rapidly and powerfully. The two phrenici in this way, equally excited, immediately cause strong heavings region. The electrodes should be sponge-covered and well moistened.

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[1] Magendie, *Journal de Physiologie.*

The results arrived at from my own practice and experiments are the following:

1. That it is useless to expect good results if five minutes have elapsed since life appeared extinct.

2. That the current should be applied faithfully and *steadily*, one pole being placed on the ensiform cartilage, the other on the base of the skull or over the tracks of the great nerves of the neck.

3. That the faradic and interrupted galvanic currents are the best.

4. That the current should be applied some time after respiratory movements have become regular.

ELECTRICITY AS A GENERAL CUTANEOUS STIMULANT.

We cannot speak too highly of electricity as a remedy, particularly in those cases of extreme prostration associated with anæmia and chlorosis, when the nutritive functions are disturbed, and assimilation of food is imperfect. The vast number of important morbid conditions, though sometimes of little moment to the physician on account of the slight evidence of symptoms, are all capable of being benefited by electricity. Hysteria, nervous asthenia, where cold hands and feet and a phosphatic condition of the urine are present, spinal congestion, and spinal irritation, are included in this list. The faradic current, applied by means of large sponges to the surface, on the plan proposed by Drs. Beard and Rockwell, produces a lasting stimulation of the skin which has decided advantages over rubbing, cold-water baths, and other means generally employed. Of course the application of faradism in this way is not within the province of the occupied physician, but should be performed by a nurse or friend of the patient. An excellent application, in cases of spinal irritation, is to the vertebral column. The faradic current is the one to be used. Faradism may be used to overcome insomnia.

CHAPTER X.

CONVULSIVE DISEASES.

Chorea.—Scrivener's Palsy.—Paralysis Agitans.—Epilepsy.—Tetanus.—Asthma.—Torticollis.—Diseases of Women.—Intra-Uterine Galvanic Pessary, etc.—Electricity in Obstetrics.—Diseases of the Eye.—Constipation and Intestinal Obstruction.—Skin-Diseases.

Chorea.—Notwithstanding the fact that Golding Bird and others have had such brilliant success with electricity, I must say that the conclusions of these gentlemen have not been verified by the several cases I have seen treated, or have treated myself. Electricity, except as a tonic in this disease, has been without virtue in my hands. Meyer recommends that the intermittent galvanic current be applied to the suffering limbs. Ullsberger, whose prize thesis I recently translated, and which appeared in the *American Journal of Obstetrics*,[1] recommends it quite highly. Galvanization of the sympathetic may be resorted to with faradization of the convulsed parts. Ullsberger cites several cases, among which are these:

Maurice Benedikt treated, among others, the daughter of a cotter, aged nine years, suffering from tonic spasms, by directing the galvanic current on the ganglia and mastoid process, continuing the *séances* two weeks and a half. The cure was perfect. He effected several other cures of idiopathic chorea. For example: a scholar, aged twelve years; a girl, the same age; the son of a laborer, aged twelve years; and a boy, aged eight years, suffering from general chorea minor. It required two months for the cure of this last case, which lasted only a year, at the end of which time a relapse occurred, from which, nevertheless, he was radically restored. The son of a shoemaker, nine years old, being affected with choretic movements of the ocular and labial muscles, was cured by the same treatment in eight weeks. A girl of twelve years of age had suffered with infantile eclampsia when she was but nine months old; later, from unilateral chorea. A galvanic application ameliorated her condition. A boy, aged twelve years, who had suffered from tænia, was completely relieved, and like success attended a girl of the same age. A boy, aged fourteen, having submitted to the faradic treatment for two months and a half, experienced such a favorable result that he continued exempt from further attacks, and his general health gained appreciably. Giovanni Finco reports the following case: A girl, aged twelve, had suffered a series of nervous symptoms, such as neuralgia of the superior cervical nerves, accompanied with sharp pains in the epigastrium, or hyperæsthesia of the left side of the neck, and of the thorax. These symptoms were complicated afterward with dysphonia and involuntary movement of the neck and arms. They were repeated every day, commencing at half-past ten in the morning, and lasting till nine at night; finally ending in gaping, great prostration, and pallor. All remedies used for a year and a half were unsuccessful, but the induced current produced visible improvement. Therefore it was in future used. The positive pole was put in one hand, and the negative pole was placed on the nape of the neck, the scapula, and the left side of the breast. After five *séances*, an amelioration was perceived; after two months, a notable improvement. At last, after a continuation of some weeks, not only had the cure become perfect, but the whole physical constitution of the patient had undergone a very advantageous change. Von Holtzbeck has enriched the records of electro-therapeutics by three cases of little girls aged seven and a half, ten and a half, and eleven years.

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[1] *American Journal of Obstetrics*, May and August, 1872.

Chorea is met with most frequently in the female sex between the ages of five and nine. This statistical fact was given to us by H. M. Hughes and E. Burton Brown. Of fourteen patients attacked with chorea, five were cured, one improved, three remained unsuccessfully treated, and in five the result was not noted. The daughter of a servant, nine years of age, emaciated and weak, suffering from St. Vitus's dance, was treated by Rudolphe Wecke. He subjected her to electric treatment, accompanied by tepid baths and cold spongings, by which the child became strong and thriving.

Scrivener's Palsy (*Writer's Spasm*, *Impaired Writing-Power*, *etc.*).—This disease is comparatively so rare that electricity has not been fully tested. It has been my good fortune to meet with a case or two, one of them quite aggravated. Both were relieved, and one cured, by the application of the two currents. The disease has been pronounced by Mr. Solly[1] to be due to a disintegration of the "vesicular neurine" in the upper part of the cord. With this affection there is little loss of sensation, but always a loss of muscular power, and an atony of the flexors of the forearm, rendering it impossible to keep the point of the pen or pencil in contact with the paper. There is a spasmodic contraction of some of the muscles of the hand and forearm, and the hand is convulsively drawn from the paper by a choreic movement increased by the exercise of the will. A galvanic current is the most beneficial, and the electrodes should be so small as to include but one muscle at a time in the circuit. The current must be mild, or it will only aggravate the disease. With this application to special muscles, one pole may be placed at the nape of the neck and the other to the muscles of the hand and forearm.

I. James McC., aged thirty-eight. The patient had followed the occupation of clerk for many years, and had assiduously worked at his desk for many hours in the day. Two weeks before I saw him he noticed an impairment in his writing-power, and this consisted in an inability to write without the occurrence of a convulsive contraction of the extensors of his right forearm, by which the pen flew from the paper. This did not occur at the moment of writing, but after a few words had been written. He attempted to keep the hand steady by the influence of the will, but all his efforts were ineffectual. When he attempted to hold the point of any small object, such as a stick or pencil, against the surface, the same spasm would occur. There was no wasting of the muscles, pain, or other symptoms. I determined to try galvanism, combined with manual exercise and the internal administration of strychnia in doses of $\frac{1}{24}$ of a grain. Galvanism of the flexors of the forearm and of the small muscles of the hand was made, and, at the same time, the positive pole was held for a few minutes at the nape of the neck. He was directed to procure the round of a chair with which to exercise. Galvanization was persevered in, although the progress was very slow. At first he could not write more than two words (almost illegibly); but, as he grew better, these spasms disappeared. Three *séances* a week, kept up for a period of about three months, effected such an improved condition that he was finally discharged at the end of that time.

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[1] "Surgical Experiences," p. 205, London, 1865.

II. "C. D.,[1] aged forty-five, applied to me in March, 1872, on account of want of power in his right hand. About two months before he had noticed that his writing became very bad, from the ring and little finger failing to give proper support to his hand as it held the pen. This difficulty increased, and was soon accompanied by inability to hold the pen firmly between the thumb and first two fingers. To obviate this, he would use a short pencil, the end of which was planted in the palm, while its axis was grasped by all the fingers, and he wrote without leaning upon the two inner ones, but sometimes used the extremity of the ulna as a support. He could not cut a pencil in the ordinary way, nor could he snap the index or middle finger against the thumb.

"For some years past he has had much brain-fag, and early in last winter he broke down in health so much that he obtained medical treatment, under which he had greatly improved. He suffered from pain at various times, sometimes seated near the scapula, at others in the hand and forearm. With the act of writing he had pains in all the muscles of the arm, and an uneasiness of mind. The hand was wasted, and there was atrophy of those muscles supplied by the ulnar nerve—notably to the dorsal interossei. There was also falling away of the plump of the thumb; there was considerable loss of power in the fingers, and none of them could be moved in a lateral direction. There was no definite loss of cutaneous sensibility in the hand; flexion was perfect, but extension imperfect, especially in the third and fourth.

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[1] Reported by Dr. Buzzard in a recent number of the London *Practitioner*.

"There was no response to the induced current of any of the muscles of the little finger, in the interossei, the adductor pollicis, nor the flexor carpi ulnaris. With the constant current (thirty-eight cells) there were brisk contractions of the interossei when labile application was made. Before the difficulty began, there was great pressure made on the upper part of this arm by the tight sleeve of a coat he had worn for some time previously.

"The patient was treated by the constant current. The *séances* were of an hour's duration, and there were three of them in a week. The positive pole was placed upon the mid-cervical region, and the negative with the hand in water for a few minutes, ten cells being employed; at other times the positive pole was applied to the elbow where the ulnar nerve is superficial. On March 30th, faradism gave contraction, and was substituted. By May 17th, muscular power had greatly returned, and the atrophy had diminished. By the end of June the patient was apparently well, and by July 11, 1872, all treatment was suspended."

Paralysis Agitans.—Galvanism of the spine may be followed by good results in this affection, but the treatment is tedious. Recent cases are only those that there is any hope for. Althaus relates a successful case, as does Dr. Russel Reynolds. In the latter, Dr. Reynolds used Pulvermacher's chain, and, after six applications, the patient recovered.

Epilepsy.—The mystery that surrounds the etiology of epilepsy leaves us very much in the dark as to what effect the electric current would have. As a general thing, the application of electricity has not been followed by any appreciable results. In some cases galvanism has given relief. Althaus recommends that the negative pole be applied to that point from which the aura starts, if it be a mucous membrane. If the aura starts from the epigastrium, the positive pole should be applied there. Dr. Hammond recommends the passage of the current through the cranium, and also the sympathetic. When the current is directed through the head, one-third of the time it should be passed antero-posteriorly, one pole being placed on the back of the neck, and the other on the forehead; for another third, one pole is placed on each mastoid process;

and for the other, one on the sympathetic nerve in the neck, and the other on the spinal column, at about the first dorsal vertebra. Ten or fifteen cups should be used. The above treatment has been in vogue at the New York State Hospital for Diseases of the Nervous System. As other remedies were used at the same time, it is impossible to definitely state really how much good galvanism did. Up to April 20, 1871, Dr. Hammond had treated, out of two hundred and six cases, one hundred and thirty in this way, and of these fifty-nine were entirely cured. Cases which I have seen myself, who before the time of treatment were attacked several times in the day, were notably relieved. The cerebral symptoms and general weakness were improved, and the number of seizures diminished.

There are other diseases of a spasmodic nature which are amenable to electrization, and these may be enumerated as torticollis, asthma, and tetanus. In the first, the sterno-cleido-mastoid and trapezius muscles are thrown into a state of contraction, through a diseased condition of the spinal accessory nerve. A galvanic current of high tension applied to the affected muscle, and the faradic current to the antagonistic muscle, will remove this condition, though very slowly.[1] Galvanization of the vagus will greatly relieve true spasmodic asthma.

Asthma Nervosum.[2]—A patient thirty years old was first attacked, when twenty-two years of age, with long-continued fits of sneezing, lasting a few hours daily, and returning periodically, which suddenly gave place, after one and a half year, to attacks of asthma. The attacks, which were very violent, appeared at first spontaneous; afterward, in consequence of very slight exertion, causing the patient great distress, notwithstanding all attempts for relief. In the spring of 1866 he consulted Caspari, who found slight emphysema, costal respiration, drawing in of the epigastrium during deep inspiration. During the attacks the diaphragm was very low down, and took no part in respiration, which was mainly costal. The galvanic treatment consisted in fixing the negative pole (diameter eight centimetres) to the sacrum, while passing the positive pole along the spine from the neck to the lumbar region. Length of each application, ten to twenty minutes, thrice, once a week. Marked improvement after five sittings. After twenty-five sittings, the attacks disappeared, and all movements of the body were possible without creating any disturbance. The patient remained entirely well until the middle of September, 1866, when slight attacks recurred, which were suppressed by fourteen sittings. Since then no recurrence.

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[1] Not more than five cells should be used at first.

[2] Reported by Dr. A. Caspari (*Beitrag zum Electro-therapeutischen Wiener Wochenblatt*, Nos. 21, 22, 1868, casuistik).

Tetanus.—Notwithstanding the fact that galvanization of the cord produces spasms in the muscles receiving their nervous supply from the part irritated, Matteucci and Nobili found that, when frogs were tetanized with strychnia, a strong galvanic current passed through the cord would restore a normal condition. Dr. Mendel, of Berlin, has treated a case of this disease successfully, and has reported it in the *Berliner Klinische Wochenschrift*, September 21, 1868. Dr. Mendel's first case was of a child aged four years. The child was run over by a wagon on May 17, 1868, and the thumb was crushed. On the 31st of May, trismus set in. Contraction of muscles of neck. No effect from opium. On June 12th, slight fever, head drawn backward, cyanosis of the face, trismus well marked. Strong contractions of the muscles of the right arm and forearm, which cannot be controlled by manual force. Muscles of back in tetanic rigidity. Muscles of thigh moderately, muscles of calf strongly contracted. Increased reflex irritability. Catarrh of the right lung.

Galvanic treatment: Eight elements, anode to the outer surface of the right forearm, cathode applied over the cervical vertebræ; immediately upon completion of the circuit, it was possible to move the hitherto rigid hand in all directions. A similar application was made to the lower extremities, the anode being placed directly on the muscles of the calf, which was not followed by benefit; the anode, however, being placed on the anterior surface of the leg, immediately under the joint, all rigidity of the calf disappeared; similar in both extremities. The trismus could not be relieved. By application of the electrodes to the side of the muscles of the neck, the rigidity of these, as of some of the muscles of the back, was diminished.

Examination on June 13th revealed an improved suppleness of the muscles. The induced current tried experimentally caused an aggravation of symptoms; the constant current caused relaxation.

June 14th.—Defervescence; only slight tension in a few muscles. After two more sittings there is, on June 18th, only slight contractions of the fingers of the right hand; no more signs of tetanus—followed by complete recovery.

III. *Idiopathic Tetanus in a Girl Eleven Years old—Cure in Ten Days by Application of the Constant Current.*—Commencement of disease on June 15th, with trismus. On June 17th, contraction of muscles of neck and calf, followed by general tetanus, with greatly-exaggerated reflex irritability. High fever; temperature 104°. In this case, also, eight to twelve elements were employed, the relaxation continuing some time after cessation of the current. After two sittings, marked improvement followed, recti-abductor muscles being tense; their relaxation was accomplished by the application of the anode to the second lumbar vertebra, and the cathode to the sternum.

June 23d.—The intervals between the attacks lengthened, and the attacks shortened. Temperature 102°. During the following days, patient continued to improve, with galvanization ten to fifteen minutes in duration.

June 29th.—Temperature normal; no more tetanic rigidity, and only slight tension of the masseters. Cure.

The author draws the following deductions: Treatment must be directed against every separate group of muscles affected. The effect follows by the influence of the current on the sensitive nerves. It is remarkable that relaxation followed most easily when the anode was placed on the antagonists of the tetanic muscles. The strength of the current must not be too great—six to ten elements; a few more in adults.

The direction of the current seems to have no influence on the effect. The induced current has no influence on the tonic contraction of the muscles.

DISEASES OF WOMEN.

The gynæcologists who have given prominence to electricity have adopted it as a very important mode of treatment in this large class of diseases. Golding Bird[1] has used static electricity, with the result of twenty cures out of twenty-four cases of amenorrhœa. Dr. A. D. Rockwell, of New York, has been remarkably successful with the cases he has treated by faradization.

I have already dwelt upon the *modus operandi* for faradization of the uterus, and the exigencies of the individual case must determine the plan of treatment. In all conditions of displacement, whether from laxity of the suspensory ligaments, or increased weight of the organ from engorgement, we may employ faradization. The different versions or flexions of the organ, when due to want of tone of the ligaments, are also relieved by the induced current. In metrorrhagia and menorrhagia, uterine contractions excited by means of this current will stop the hæmorrhage. In metritis, faradization will produce good results not obtainable at times by other treatment.

Sir J. Y. Simpson, of Edinburgh, and Drs. T. G. Thomas, Noeggerath, and Murray, of this city, have each been successful in certain uterine diseases with a little instrument known as the "intra-uterine galvanic pessary." These are made of beads or disks of two opposite electric elements strung on a central support terminating in a bulb, which keeps them in place in the uterine cavity. Dr. Thomas has had many cases of amenor-

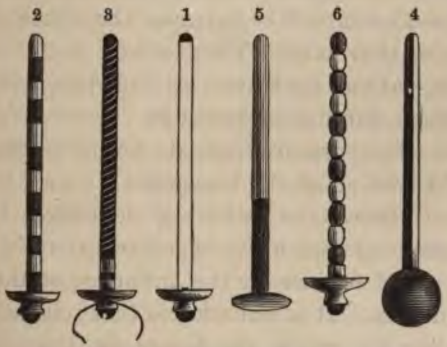

FIG. 44.—INTRA-UTERINE GALVANIC PESSARIES.

1. Sir J. Y. Simpson's.
2. Dr. Noeggerath's.
3. Dr Thomas's.
4. Dr. Thomas's improved.
5 and 6. Dr. Murray's.

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[1] Quoted by Althaus, p. 625.

rhœa and dysmenorrhœa that have been cured in this way. It is a valuable instrument for increasing the size of an undeveloped or *dwarfed uterus.*

Dr. Fordyce Barker and others have used Garrat's disks in many uterine disorders. They have been particularly successful where a mild counter-irritant was required.

ELECTRICITY IN OBSTETRICS.

When we consider that the uterus is a muscular organ, and that, like all other organs containing muscular tissue, it will contract when stimulated by electricity, we must arrive at the conclusion that, in an atonic condition, we may readily make it eject its contents by the application of a faradic current. This fact, though doubted by Scanzoni and the late Sir J. Y. Simpson, has been proved by others, among them Drs. Radford and Barnes.

Electricity is recommended in tedious labor, hæmorrhage, or for bringing on uterine contractions in special conditions when they are desired. We may apply one pole over the lumbar vertebræ, and the other to the cervix; or, as recommended by Dr. Barnes, both sponges to the abdominal parietes. The current must be mild, otherwise there is great danger of producing the death of the child, or convulsions and other bad symptoms upon the mother. We may claim, as the advantages of its use—1. The contractions are more energetic than those produced by ergot. 2. Its action is immediate. 3. It can be used when swallowing is impaired, and the patient cannot take ergot. 4. The contractions are regular and normal.

Diseases of the Eye.—In cases of amaurosis, the *bain électrique* may be employed with success. For weakness of sight, and photophobia, we can also use the galvanic current. There are various changes in the cornea that may be influenced by electricity. Slight opacity may be removed in a very short time by the galvanic current, but a *total* opacity of that part of the eye requires more patience. Electricity may be applied to the closed eyelids by a sponge, or locally by smooth metallic conductors. Not more than from two to five cells should be used. Dr. Noyes, of New York, reports a very interesting case of structural change of the eyeball, dependent upon a paralysis of the fifth cranial nerve.

The following case is one of paralysis of the upper two branches of the fifth nerve, and only partial affection of the third or submaxillary division. It has a special interest because of the striking benefit which has been derived from the galvanic current:[1]

Amelia McC., aged seventeen, came to the New York Eye and Ear Infirmary October 14, 1870. The right eye had for five days been inflamed, and while there was moderately intense injection of the conjunctival and scleral vessels and the whole cornea was ulcerated, there was no expression of pain nor intolerance of light; I at once, from this passive behavior, suspected the fifth nerve to be at fault, and found such to be the fact. I could put my finger on the cornea and the conjunctiva without causing the patient to shrink. She had an eruption on the skin of the right half of the forehead and the side of the nose, as parts supplied by branches of the ophthalmic nerve: this continued for a few weeks, and disappeared. On inquiry, I learned that in August preceding a numbness had befallen this side of the face and head after she had suffered from a severe headache—an attack much worse than any she had had before. There had been no other special symptoms, and the matter was considered unimportant. The inflammation of the eye came on spontaneously. I carefully examined the region of insensibility, and found it was terminated accurately by the median line of the face in front, that it included the upper lip, side of the nose, eyeball and lids, forehead and scalp nearly to the vertex, temple, and anterior two-thirds of the cheek. The chin, the cheek in front of the ear, and the auricle and neck, had sensibility, though in slightly-diminished degree. The left side of the face was perfectly natural. There was loss of sensibility on the right half of the tongue, the upper lip and gum and inside of the cheek, and the anterior pillar of the fauces. Sense of taste she did not perceive to be impaired. The right nostril could be tickled with impunity, and a Eustachian catheter did not excite resistance until it arrived at the soft palate. Contraction of the palatine muscles was normal, and the masseter on the right side seemed as vigorous as on the left.

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[1] Reported by Dr. Noyes, *New York Medical Journal*, August, 1871.

The nature of the corneal inflammation being clearly indicated, I determined to try the benefit of the galvanic battery, and sent the girl to Dr. Guleke, who kindly consented to conduct this part of the treatment. I directed, in addition, the use of sulphate of atropia, of hot fomentations, and occlusion of the eye by a bandage.

The surface of the cornea was entirely stripped of epithelium to its margin, although its deeper tissue was almost transparent; iris and pupil could be distinctly seen. After three applications of the constant current, I was surprised at the improvement in the cornea. Although the inflammatory redness continued about the same, the epithelium had been regenerated all around its rim, making a circle at least one-tenth of an inch wide, and leaving a central bared portion about two lines across. During the following week the growth of epithelium continued, but less rapidly, and the injection of the eyeball diminished. The sensibility of the cheek improved, the posterior limit of the numb region coming a little forward. After this time the keratitis grew worse, the central ulcer widened, and the tissue of the cornea became infiltrated with pus. There were two small ulcers in the cornea. At the fifth week of the disease, the patient's condition was very bad; from that time improvement was rapid. Perforation of the cornea did not take place.

Subsequent progress: By January 1st the cornea was nearly all covered with whitish, thick epithelium containing blood-vessels. The opacity of the cornea grew less. There was no marked loss of tension of the globe. While the eye improved, the sensibility of the face equally increased. The dividing line between the numb and sensitive region ran from the middle of the zygoma to the angle of the mouth—this advanced farther upon the malar bone, so as to come within half an inch of the outer palpebral commissure—but the side of the nose and upper lip remained insensible. The forehead also recovered down to the eyebrow, but the lids and conjunctiva are anæsthetic. It must be noted that the patient is always aware when firm pressure is made, although so indifferent to pain that she once blistered the cheek by applying scalding water, and did not know it. In examining the right ear I found the membrana tympani opaque, its epidermoid layer thickened, and the appearances such as belong to subacute otitis media. Watch heard only when it touched the auricle. The membrana tympani could be touched more roughly than the normal drum membrane, although it had sensibility. The meatus auditorius showed a diminished though moderate degree of sensation in all parts, except on a spot about the middle of the anterior wall, nearly half an inch in length, which was entirely devoid of sensation. I was struck by this circumstance, and tested the fact several times to be sure of it. I am at a loss to give any anatomical explanation for it. The impaired hearing is evidently due to catarrhal inflammation of the middle ear.

The treatment by galvanization has been steadily kept up by Dr. Guleke, who has supplied the subjoined notes:

"Examination by the constant current shows loss of feeling on the right side in the first and second branches of the fifth nerve. The third branch does not show quite so much reaction as on the left side. Contraction of the muscles of the affected region is found weak on reversing the current, and most so around the eye and angle of the mouth. The interrupted current gives contraction of the muscles of the right side in the same degree as on the left.

"Application.—The positive pole applied to the ganglion superioris of the sympathetic on the right side of the neck; the negative pole near the eye, or on the forehead or cheek. The positive pole was changed to the spinous processes of the upper vertebræ, when the place over the ganglion was too much irritated. The strength of the current was from four pairs of cells to six pairs in the later period of treatment. The first three or four months the electricity was daily used, later the patient came about every other day. The length of each application was from three to four minutes."

Dr. Arcola, of Palermo, has already employed this remedy with success in granulations of the conjunctiva; and Dr. Kohn, of Berlin, obtained successful results in seventeen cases.[1] The negative pole of the battery is applied, by means of a buttoned sound, to the inverted surface of the upper lid and conjunctiva.

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[1] "Elements d'electro thérapie oculaire," in *Gazetta Clinica di Palermo*, 1870.

The positive pole is applied to the nuchæ by a sponge saturated with salt-water. The first session is of ten minutes' duration. Dr. Schivardi publishes three cases of old granulations lasting respectively, in duration, two, three, and eight years. The first case was cured in five sessions; the second was decidedly improved in two sessions; the third, affected also with concomitant blepharitis and pannus, not only recovered from these affections, but also regained sight in nine sessions. To practise electrization three assistants are required; one to hold the positive pole, the other the negative, the third holds the lid reversed and the head fixed.

Constipation.—When the contents of the rectum accumulate on account of an atonic state of the muscular tissue of that gut, it is extremely difficult to find a remedy that will remove the obstruction without eventually increasing the atony by reaction. In some cases the presence of diarrhœa may forbid the use of laxative medicines; electricity is then indicated. When peristaltic motion is diminished, we may use the currents as directed in another chapter.

Prof. Benedikt recommends the use of the primary induced current in constipation; one electrode to be placed in the lumbar region, the other at numerous points on the abdominal wall. The abdominal pole must be pushed hard down upon the abdominal wall, and a very strong current be used. Prof. Benedikt thinks the treatment is of especial value in cases of obstinate chronic constipation in which there is a tendency to hypochondriasis. He relates the case of an officer who had been severely wounded eight months before coming under treatment, during which time he had not had a stool save by the use of medicines, but in whom the electrical excitation always produced a natural evacuation. Three weeks of daily treatment served to cure the case.[1] Prof. Benedikt states that, in numerous cases of constipation occurring in spinal and cerebral disease, he has derived great benefit from the method described.

Althaus also recommends it in tympanites and flatulency. Fardization of the rectum is the most available way to remove those accumulations of gas.

[1] *Wiener Medical Presse*, No. 37, 1867.

Dr. M. Macario[1] reports a case of obstinate constipation in a man seventy-one years old, which was successfully treated by the induction-current. A metallic electrode was introduced into the rectum, and the other passed over the transverse colon. By application of a strong current during ten minutes, the abdominal muscles contracted energetically, and acted "like the troubled sea." Patient complained of severe pain. Immediately after discontinuance, improvement followed; cessation of stercoraceous vomiting. In four hours evacuations were free.

Intestinal Obstruction.—Dr. Löwy[2] relates the case of a boy, aged nineteen, who was affected with typhoid fever in July, 1870, followed by ulceration of the intestines and general peritonitis. The symptoms of hiccough, nausea, vomiting of green matter, and collapse, ensued. Löwy introduced into the rectum a sound connected with Du Bois-Reymond's apparatus, and placed the other pole over the location of the pylorus. The current was applied for fifteen minutes. When it was remitted, the patient vomited stercoraceous matter containing grape-seeds. The battery was again applied in the evening, and more fluid was vomited. In a few days another strong current was applied, and a stool containing a hard body, the size of a hen's-egg, came away. This body was composed exclusively of grape skins and seeds. The boy gradually recovered his health.

THE TREATMENT OF SKIN-DISEASES BY ELECTRICITY.

It is the general opinion of dermatologists nowadays, I believe, that skin-diseases are simply neuroses. Neumann, Bärensprung, and others, unite in this conclusion. Numerous experiments substantiate the truth of this assertion, and have proved that nearly all skin-diseases are amenable to electricity. Cazenave and Romberg consider prurigo a nervous disease. It is incontrovertible that urticaria and other diseases characterized by nervous irritation are but morbid states of the ultimate cutaneous nerves. The consideration of the fact that the vasomotor system of nerves is directly influenced by the sympathetic, will enable us to understand why galvanization of this trunk will eventually influence the nerves supplying the minute vessels of the skin.[1]

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[1] *Annali universi di medicale*, October, 1870.

[2] *Wiener Medical Presse*, No. 37, 1867.

Purely local diseases may be treated by galvanization or faradization of the skin itself.

Dr. E. L. Mann,[2] of Brooklyn, has contributed to the *Medical Record* a most valuable article upon the treatment of skin-diseases. He presents a number of reliable cases, some complicated with other affections, in which galvanization of the sympathetic was followed by a rapid cure. I extract the following case from Dr. Mann's article:

I. "Miss O'C. Eczema following intermittent fever. Has had four succeeding attacks, which reduced her health, rendering her weak and anæmic. A short time after the last attack her legs began to swell, the swelling being accompanied with erythematous redness and a vesicular eruption, discharging a watery exudation which formed yellowish crusts. This eruption was accompanied by burning and pain, and a great deal of itching. The hands were swollen. The eruption also appeared on the head and back. Four *séances* of central galvanization completely cured her, the length of the application being about fifteen minutes, and being made about twice a week. She has at present a good appetite, and is gaining flesh. There is no sign of the eruption."

Dr. Mann has also treated several cases of pruritus and other diseases.

In herpes zoster I have had success, as the following case will show:

II. M. C., twenty-six years of age. The patient had been affected for some time with a vesicular eruption on the right side, beginning in the groin and arching over the crest of the ilium, extending as far back as the vertebral column. Two successive patches had appeared, and he was so tortured with neuralgic pains as to lose all rest. I applied a metallic electrode (negative) to the eruption itself, and the positive pole over the lumbar vertebræ. The pain disappeared in two or three minutes; and, when I next saw him (a week afterward), the eruption had completely dried up.

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[1] Dr. Edward Frankel, of New York, informs me that he has had a case under his charge where eczema was associated with chorea, and that the subsidence of the latter disease was accompanied with a disappearance of the eczema.

[2] *Medical Record*, October 1, 1872, p. 412.

Bärensprung supposes the origin of herpes zoster to be an inflammation of the sympathetic fibres of the small spinal ganglion. This, he thinks, accounts for the neuralgia.

The rapidity with which my case recovered fully goes to prove the above statement.

Dr. H. G. Piffard, of New York, has had remarkable success. A case of scleroderma, which would not yield to other treatment, was very soon cured by this means. Dr. A. D. Rockwell informs me that he cured a person with tinea circinatus in one *séance*.

III. *Psoriasis treated exclusively with the Galvanic Current.*—The patient was forty years of age, a native of Ireland, and had suffered from psoriasis for seven years. The diseased patches occurred on the elbows, shins, back, and below the breasts, varying from one to three inches in diameter. Her general health was good, but she occasionally suffered from ovarian irritation. Carbolic acid (internally) and arsenic were first tried, but found to be useless, upon which Dr. Piffard determined to treat her by galvanism. The positive pole of the battery was applied to the nape of the neck, and a negative pole, with sponge-electrode, was passed over the surface of the affected patches. The strength of the current was regulated by the sensation of the patient, the intensity being as great as could be borne without discomfort. The application varied in duration from one to three minutes for each spot. Without entering into a full description of the progress of the case, which is extremely interesting, suffice it to say that the progressive improvement occurred—noticed especially in the patches, to which the applications were made with greatest frequency—and in about six weeks the disease had entirely disappeared. During the entire period of galvanic treatment the patient received no external or internal treatment, with the exception of a little rhubarb and soda given during the first week. Dr. Piffard, at his dispensary, has employed the continuous current in several cases of eczema, in pityriasis of the scalp, in scleroderma, seborrhœa, and in one case of enlargement of the nose depending upon great increase in size of the sebaceous follicles with infiltration of the interfollicular tissues, and in one case of non-parasitic sycosis. The doctor ends a most interesting communication by stating that "the results thus far obtained, though by no means uniformly successful, are sufficiently encouraging to warrant further observation of the effect of this agent upon morbid conditions of the integument."[1]

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[1] Reported by Dr. H. G. Piffard, in *The Doctor*, August 1, 1871.

CHAPTER XI.

ELECTROLYSIS.

Theory of Electrolysis.—Anions and Cations, etc.—Steps of Operation.—Needles and Apparatus.—Electrolysis of Aneurisms (Galvano-puncture).—Malignant, Erectile, and Serous Tumors.—Goitre.—Hydatids.—Hydrocele.—Stricture.—Galvano-therapy of Wounds and Ulcers, Nævi, etc.

BEFORE we enter into the consideration of electrolysis as a therapeutical means, it may be well to briefly consider its philosophy. Electrolysis is eminently a chemical process, and may be defined as *a change or division of a compound body through the catalytic agency of electricity.* We call a substance capable of such analysis, an *electrolyte.* All substances are good *electrolytes* which contain water, and the quantity of water and soluble salts they contain gauges their conductibility and capacity for electric decomposition.

When the positive and negative poles are immersed in a fluid, we find that the decomposed parts of the substance collect at the respective poles, and to those that are decomposed at the positive pole we give the name *anions;* at the negative, *cations.*

When we decompose water, we find, for instance, that oxygen is set free at the positive pole, and hydrogen at the negative; therefore they are respectively *anion* and *cation.*

The different tissues found in the body, whether they be heterologous or homologous, are capable of being disorganized by this action. I have spoken before of the phenomena exhibited when blood is submitted to this process; other fluids and substances are subject to changes also. Some writers, among them Dr. Neftel, of this city, state, and prove their assertion with cases, that malignant growths may be destroyed by an electrolyzation of their substance.[1] Neftel goes so far as to say that it exercises a constitutional effect in suppressing or neutralizing a cancerous diathesis; "the cancer-cells have their protoplasmatic contents so altered as to make the formation of new deposit impossible." Electrolysis may be used for the dispersion of tumors or morbid growths, or collections of serous fluid.

For the operations of electrolysis we require a battery capable of producing currents of tension without too great "quantity." With quantity we get heat, and this is fatal to success.

Electrolysis may be performed either by external[2] or internal action. For the former method we may apply flat sponges or plates of metal; for internal electrolyzation we use needles. There has been so much dispute upon this point that I hesitate in recommending any particular kind. Zinc, platinum, silver, and gold, have been lauded.[3] Dr. Keyes, in the performance of some very valuable experiments last year, tried hollow needles for aneurisms, but abandoned their use; he finally arrived at the conclusion that gold were the best. In my experience, steel needles covered with gold, and afterward insulated, were most reliable. Dr. A. D. Rockwell says:[4] "It has been found that electrolytic action is very materially modified according to the nature of three important factors: 1. The composition of the substance decomposed. 2. The material of which the electrode is made. 3. The strength of the current employed."

Under the first head we will find that some substances decompose much more readily than others; under the second, that some electrodes are better conductors of the current than others, or are more oxidizable; and, on consideration of the third, we find that a *condensed* current (that is, when greater resistance is offered by a small needle or conductor) will produce electrolytic effects much more quickly and effectually than when the current is diffused. The action of the current, when two needles connected with the poles of a battery are thrust into a piece of animal tissue, is as follows: At the positive pole, the formation of acid will coagulate the albumen, and render the parts in the vicinity tough and hard. At the negative, the surrounding parts are shrunken.

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[1] *Medical Record*, September 1, 1869.

[2] Baumgartner's experiments clearly prove that an electrolytic effect follows external transmission of the current.

[3] *New York Medical Journal*, July, 1871, p. 3.

[4] "Practical Electro-Therapeutics," *New York Medical Journal*, December, 1871, p. 577.

When the two needles are thrust into a cavity filled with blood, we have the phenomena described in a previous chapter. Litmus-paper will demonstrate the presence of acid at the positive pole, and at the negative pole the original color will be restored.

Electrolytic effects may be produced in other ways, by external application. When a deposit or exudation, which is the product of disease, is treated in this manner, the substance is disorganized, and the vessels dilated so that they remove the disintegrated matter. In goitre and other like diseases, in the exudations of rheumatism, etc., this process goes on till the enlargement is finally reduced. Dr. Murray has been in the habit of using the needle shown in Fig. 45; while, for cases where many needles are to be inserted, several instrument-makers make the apparatus, Fig. 46. For general use, I strongly advocate a large steel gilt needle, well insulated to within a few lines of its point.

FIG. 45.

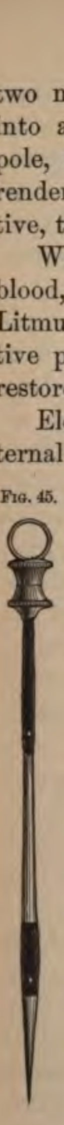
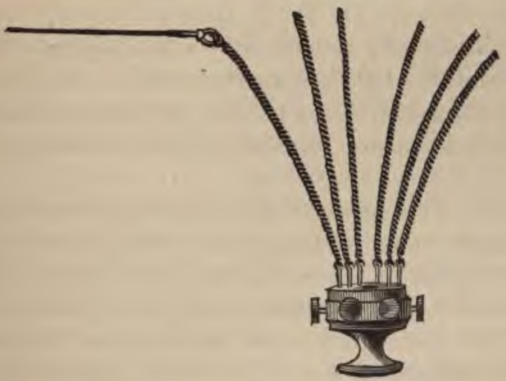


FIG. 46.



When we insert two needles of this kind into a tumor, a chemical action takes place, absorption is induced, and disintegration and atrophy finally occur.

We should test the strength of the battery before proceeding with the operation, and this may be done by the decomposition of a solution of iodide of potassium. The rapidity with which the evolution of free iodine occurs, will give some idea of the intensity of the current.

Electrolyzation of Aneurisms—Galvano-Puncture.—Ciniselli has been the great worker in this field, and his success has been more evident than that of any other operator. In a thesis written over three years ago, I traced as faithfully as possible the history and success of this mode of treatment; since that time others in this country have taken up the subject, and have given their results to the public. Dr. Keyes, of this city, in the summer of 1871, experimented most carefully, and, after trying galvano-puncture in a case of aneurism of the abdominal aorta, came to the conclusion that, though his case was not cured, it is well to attempt this treatment in abdominal aneurisms; that in these cases peritonitis is not necessarily produced, and that the danger of the operation is inconsiderable.

Dr. R. S. Lincoln,[1] also of New York, treated an aneurism of the arch of the aorta more successfully, and, in an article relating his case, finally says: "We have grounds for encouragement that promise a measure of success where formerly a speedy death seemed inevitable."

The action of the current in the aneurismal cavity is attended by a deposition of fibrine in the neighborhood of the positive pole, and this eventually fills up the aneurismal sac. The appearance of a positive clot may be seen in Fig. 47. This fibrous structure is deposited on the sides of the sac in laminations which can be readily stripped from one another. When the aneurismal cavity is filled, this lowly-organized structure is gradually absorbed, as is the rule with the majority of false membranes and tissues found in other parts of the body.

Having considered the pathology of the process, I will now speak of the operation. For some weeks before, the patient should be put upon as nearly a perfect animal diet as is consistent with health, with the idea of increasing the plastic elements of the blood. For several days previous to the first operation, he should be given digitalis or aconite. During the operation, a large room with plenty of fresh air is conducive to success.

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[1] *Medical Record*, May 15, 1871.

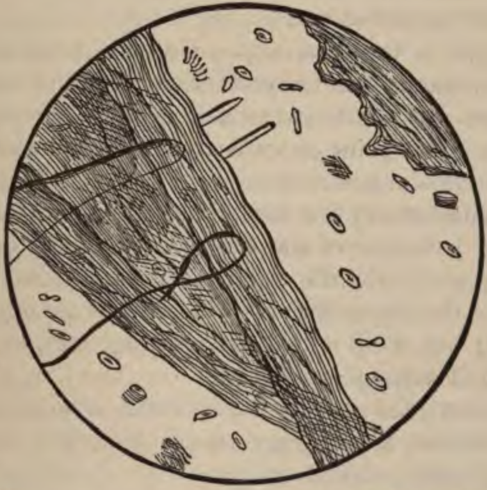

FIG. 47.—Microscopic appearance of a blood-clot from the end of a galvanic needle.

The patient should be laid on a low bed, perfectly level, that the circulation may be equable and unconstrained; the surface should be kept warm, and the surroundings be such that the patient's mind may not be excited by any of the preparations. On one side (usually that nearest the part to be operated upon) a small table is to be placed, on which the battery is laid. An assistant watches the pulse, while another administers the anæsthetic, ether being the most desirable.

When the patient is fully anæsthetized, which is necessary, for the pain is intense, the operator, taking the positive needle, which is gilded and coated with some insulating substance, and the negative, a metal plate, covered with sponge, inserts the former to such a depth that several lines uninsulated penetrate the cavity, and holds the latter (the sponge having been moistened) at a point as nearly opposite the insertion of the positive as possible.

The battery, which should consist of at least twenty-five cells, is let gradually on, using but few cells at first, and increasing gradually as the operation goes on. The assistant at the pulse now will feel a great irregularity in its action, increasing at first, generally, next decreasing, and remaining so.

The tumor will become red, œdematous about the entrance of the needle (positive), and greatly distended, by the rapid formation of gas in the interior; at the same time, there will be a rapid increase in the temperature, and, if this continues in violence, we may safely judge that a secondary inflammation will follow. The point of application of the negative sponge will be vesicated and excoriated.

After withdrawing the needles, at the expiration of such a time as the judgment of the surgeon shall suggest, the finger should be placed over the point of entrance. Should hæmorrhage occur, the liquor ferri persulphate will quickly stanch the slight flow; but, if all is well, the opening may be closed by a small piece of adhesive plaster.

In removing the needle the operator often finds difficulty, for large masses of clot may render its withdrawal no easy matter; a steady, careful traction, will effectually accomplish the matter, however.

The needle is always corroded by the excess of acid generated, and often it is found to be reduced in size to a mere hair.

The time during which the needles are allowed to remain in the cavity depends greatly on the size of the tumor, and the force of the current. Cases have been known in which twenty minutes sufficed to completely solidify the growth and stop all pulsation. If a moderate *séance* of from fifteen to thirty minutes is not sufficient, a repetition of the operation may be performed. Niccoli made as many as six operations in a week, though it is best to allow longer intervals to elapse, that the inflammation may not be too violent. Dr. Keyes used the current for over an hour in one case!

It is advisable to press the distal ends of the artery or arteries, which the aneurism involves; by this precaution coagulation is rendered easier, and the possibility of the detachment of small pieces of the clot that might form emboli is prevented.

I deem it important to again refer to the pain which invariably accompanies the operation, and the necessity for an anæsthetic. The Italian surgeons unanimously affirm that the pain is intense, and Phillips states that in several of his cases the patients fainted from sheer physical exhaustion.

During the operation a "moist *râle*" will be audible; this is caused by the rapid evolution of small bubbles of gas rising to the surface and breaking; they are chiefly hydrogen gas, and are liberated from the negative pole.

Coagulation not occurring in such a degree as to fill up the aneurism completely, a mechanical deposit of fibrine effects the final solidification. If this does not follow, a mild inflammatory process, from the heat generated during the operation, fills the sac by its products. The success of the operation depends on the following conditions, viz.:

1. The size of the aneurism.
2. A proper insulation.
3. The exact amount of galvanic force.

1. In large aneurisms, with thin walls, and violent pulsation, the success of the operation is not evident; not only is the production of a galvanic clot a difficult matter, but so great is the force of the circulating current, that the process is highly impracticable.

2. A proper covering of the needle by some non-conductor is of the utmost importance. If this is not carefully attended to, the heat produced by a large exposed non-conducting surface will give rise to a violent secondary inflammation, so severe that the entire sac may subsequently slough away—a most unhappy occurrence.

Another deplorable danger, and one that has seriously affected the success of the earliest operators, is the sloughing of the track of the non-insulated needle. When, in such cases, the slough separates, it will come away in the form of a cone, the base above; the diffusion of the current in this shape is supposed to account for it. The consequences, secondary hæmorrhage, can be fully realized.

To prevent these dangers, the needle has been insulated by various substances with different success. Petrequin recommends wax; Broca, shellac; Phillips, black enamel; Keyes, hard rubber, etc.

The following is a formula with which I coated the needles successfully used in a case to be presently alluded to. None of the destruction of tissue followed, and but a slight black spot, with a few enlarged surrounding capillaries, marked the entrance:

℞.	Gum-shellac (brown)	1 drachm.
	Solution India-rubber (Squibb's)	1½ "
	Wood Naptha	2 "

3. The force and power of the galvanic battery should be carefully regulated. Too great an action may form a very curdy, loose clot, easily broken up by the circulating blood, and carried off as emboli.

This production of emboli Morgan[1] denies, and insists that, when existing, they are but small fragments, torn from the sloughing membrane, that always is found after the operation in some amount. The rapid evolution of gas may seem dangerous, when the action is exceedingly violent, but Nysten[2] found that from forty to one hundred per cent. of air had to be suddenly introduced into the jugular vein to produce death—much more than is possible here.

Too weak a current will prevent the formation of clots.

The dangers of the operation have indeed been magnified, and assuredly upon slight foundation. In the crude workings of the earlier experimenters on the subject, a general want of proper knowledge and apparatus has defeated success. It must be evident to all that proper manipulation and care will assist the intelligent surgeon to make the procedure a safe and valuable one. The discoveries of the Italians were characterized by the peculiar implements with which they worked. Perhaps the most striking example was the galvanic pile of Volta. This apparatus was even used by Petrequin and Broca a quarter of a century ago.

Having considered the most interesting points of the operation, it is well to inquire into its applicability and chances of success. The most striking cases are those for which we can usually give no relief, and cannot do more than tell the patient that he must die. These are aneurism of the great vessels;

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[1] Morgan, "Electro-Physiology and Therapeutics."

[2] Bouillard, "L'Introduction de l'Air dans les Veins."

abdominal and thoracic aorta, the innominate, subclavian and iliac arteries, when ligation or other measures may be impracticable or impossible. In cases where great debility is present, we may employ this process.

As in all other surgical operations which have been given to the world, we are unable to obtain *exact* reports, either of success or not, and the statistics preserved are neither complete nor definite. I have, however, obtained the following: Bovinet,[1] in a report made in 1853, gave thirty-two cases of aneurism treated. Of these, twenty-one were unsuccessful, one doubtful, and ten successful. Of these ten, seven were situated upon the small arteries of the extremities, and, in the three others, two popliteal and one subclavian, suppuration followed. One of the popliteal cases, moreover, left the hospital with a tumor, as large as a hen's-egg, under his knee.

Petrequin reports sixty cases, seven of which died, twenty-three were cured, twenty were not; the rest were doubtful. Petrequin operated three times successfully on the subclavian. Niccoli successfully treated two cases of aneurism of the aorta, and another of aneurism of the facial artery. Sir Wm. Hamilton reports a successful case of aneurism of the carotid; Schuch one unsuccessful case of subclavian aneurism; Ciniselli reports twenty-three cases, out of which sixteen died and six were cured, one disappeared; Genmireau, of Pisa, one of palmar; Dr. H. B. Sand, of New York, one of subclavian, which was unsuccessfully treated; Dr. E. L. Keyes, of New York, one of abdominal aneurism, which was also unsuccessful. This makes a total of one hundred and twenty-six cases, of which, as far as I can learn, forty-eight were cured; the rest were doubtful, or not cured.

I. *Case of Aneurism of the Subclavian.*[2]—P. K., a sailor, nineteen years old. He had fallen from the foretop of the vessel and had struck upon his chin, thus causing a sudden and violent extension of the neck. This occurred eight weeks ago. Besides this, one or two lacerated wounds of the soft parts covering the inferior maxilla. No injury was discovered at the time of the accident. A few days afterward, however, the patient began to suffer from slight pain and numbness in the arm and shoulder, and in the course of a fortnight a pulsating tumor was noticed on the right side of the neck, close to the larynx, and at that time had acquired very formidable dimensions. It occupied most of the lateral triangle of the neck, and extended inward beneath the sterno-cleido-mastoid muscle as far as the median line. Its shape was pyramidal, the apex somewhat rounded off, reaching as high as the top of the larynx, while the base extended downward behind the clavicle and sternum. The sternal end of the clavicle was partially dislocated forward and pulsated strongly, as did all those portions of the tumor which could be examined. The aneurismal murmur was also exceedingly well marked. The pupil of the right eye was contracted, probably from the pressure of the tumor upon the cervical portion of the great sympathetic. The tumor itself was very readily compressed, showing that its contents were fluid. The pulsations of the right carotid and brachial arteries were more feeble than those of the corresponding vessels of the opposite side, the difference, however, being only slight in the carotids. "On the outer side of the tumor the finger could be passed behind the clavicle, and, by pressing in the direction of the first rib, I was able to arrest the pulsations of the radial artery."

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[1] "Des Anévrismes et de leur Traitement," Paris, 1856.

[2] Dr. H. B. Sand's case.

In regard to diagnosis, no doubt existed as to the character of the aneurism. Further examination revealed an aneurism of the first part of the subclavian.

The magnitude of the aneurism and its proximity to the great trunks, combined with the low state of the patient, precluded surgical interference by the ligature. Pressure (digital) was tried, however, by twelve students. This was commenced on the 23d of March and continued for twenty-six hours, but the only result was a large ulceration of a gangrenous nature, produced by the fingers of the operators. This largely covered the sac, and at one time threatened to eat through the sac wall and produce secondary hæmorrhage.

On the 15th of April, with the aid of Dr. Gueleke, of this city, galvano-puncture was performed. One gilded needle insulated was attached to the positive pole, while the negative was fastened to a handle holding a steel plate covered by sponge. The elements were twenty in number, and were a modification of Bunsen.

The needle was introduced at the upper part of the sac—the negative sponge was placed at the upper part of the sternum. The current was applied fifteen minutes. The pulse stood during the operation:

		P. M.	PULSE.
Needle introduced	15 minutes	5.09,	140
		5.12,	128
		5.14	120
		5.16,	136
		5.19,	120
		5.24,	needle removed.

During the operation a slight tumefaction was noticeable; at the negative spot the skin was vesicated. No bad effects followed. May 22d, operation repeated. May 26th, again—each operation lasting fifteen minutes. Notwithstanding the tumor became firmer, it enlarged so rapidly and produced so much pain that, at the patient's request, galvano-puncture was not repeated. On the 9th of June the patient was suddenly stricken down by the bursting of the aneurism externally; the hæmorrhage recurred on the 12th, and proved fatal. The rupture took place through the ulcer.

Post-mortem examination showed that the aneurism involved the first part of the subclavian; that it was produced by the forcible tearing away of the thyroid axis. The internal jugular vein, pneumogastric nerve, and carotid, are pushed, with the larynx, far to the left of the median line.

When the sac was laid open, over three pounds of coagulum were found. At the entrance of the needles, exteriorly, were two or three little charred spots, while internally large masses of white, stratified fibrinous clots were attached at these points. This clot must have occupied nearly two-thirds of the sac. "It is impossible to avoid the conclusion that, in this case, galvano-puncture, though it failed to cure the disease, yet caused the deposit of stratified fibrine to an extent which, in a less formidable aneurism, might have brought about the desired result."

A Case of Aneurism of the Arch of the Aorta, treated by Electrolysis.[1] *February 6th.*—Mr. H., a miner, was brought to me for consultation by his physician, Dr. Stearns, of Buffalo. The history of the patient was as follows:[2]

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[1] Treated by Dr. R. P. Lincoln, of New York. [2] *Medical Record*, May 15, 1871.

He was thirty-seven years of age, born in Vermont. For several years he followed the sea as a common sailor, but for the past five years he had worked in the mines of California. His general appearance was that of an active, robust man. He had never suffered from illness other than intermittent fever. There was no history of syphilis or rheumatism. He was not conscious of ever having overtaxed his strength in lifting or otherwise. On the 15th of last June, while leisurely walking, he fell, and on rising found he did not have perfect control of the right half of the body, and that there was some numbness throughout the same side. During the succeeding twenty-four hours he sustained six of these shocks, losing consciousness during only the last two, which continued but ten or fifteen minutes, though the impairment of sensation and motion persisted from the first, and was never wholly recovered from. Immediately following those attacks, he suffered pain in the right shoulder, extending up the side of the neck and head, and two or three weeks later in the left also, in both of which it had continued with increasing severity. About December 1st, a small pulsative tumor was discovered in the peri-sternal notch, which has steadily increased in size; within the two weeks previous to my seeing him it had doubled. He could swallow only liquid food, breathed rather loudly, and within a few days had some cough, the cause of which was not removed by the effort. His radial pulse was 112, regular and equal in both wrists, but weak; there was no pulsation in the left carotid. The laryngoscope revealed nothing of importance.

To inspection there was presented a uniformly rounded tumor situated in the median line, and extending from the pomum Adami to one inch below the normal situation of the upper margin of the manubrium, the latter having been absorbed to that extent. The sternal ends of the clavicles were dislocated forward. The larynx and trachea were crowded slightly to the right, but the prominence of the tumor was equal on either side of the median line, and measured over its apex, either transversely or vertically, four inches and a half. The apex of neither lung seemed to be encroached upon, percussion of these being normal both in front and behind, and respiratory murmur natural. The pulsation and sounds of the heart were both natural. To palpation the tumor was elastic and pulsating, with a distinct thrill, and, on applying the stethoscope, a distinct whiz, with each pulsation, over the whole tumor, that could be traced as far as the heart. I diagnosed an aneurism of the arch of the aorta, and advised, as the only means of relief, electrolysis combined with a modification of the method known as Valsalva's. The patient was seen at this time by Dr. Sass, and also by Prof. Markoe, who approved of the course recommended, the latter thinking it probable, from the position and size of the tumor, that the innominate artery was involved at its origin.

"The patient left the city, but returned, so that the first operation was made February 20th.

"During the time (two weeks) that had elapsed, the tumor had apparently doubled its size, and measured six and one-half inches, where it measured but four and one-half before. The pain in the shoulders was now so great as to prevent more than two or three hours' sleep at night, and he was weaker in every respect. For four days previous to the first operation the patient was kept in bed, and iron, quinine, and digitalis, administered by day, and morphine at night. At the time of the operation all the symptoms were aggravated, except the pulse, which was 104.

"The method practised by Ciniselli was followed in the operation as far as practicable, and was only modified as the nature of the case seemed to demand. Seven steel needles, insulated to within one and a half inch of their points, were introduced into the prominent parts of the tumor, one inch and three-fourths below the surface of the integument, and three-fourths of an inch from each other. The cathode and anode were each subdivided into two, and the positive pole preceded the negative as the current passed through each. Every time the poles were changed the number of elements was increased from one to ten, the battery used being a modification of Stöhrer's. No anæsthetic was used in this or the following operation, and the increase of the pain forbade the use of a larger number of elements. The current was closed forty minutes in all.

"During the operation the diminution of the distinctness of the pulsation was very marked, and the patient complained only of a burning pain, which became greater with the increase of the number of elements. On removing the needles, gas escaped for a few seconds from each puncture, and with the gas small pieces of clotted blood. The pulsation had almost entirely ceased, and the tumor had a hard feel and was somewhat distended. The integument over the tumor was red. An ice-bag and a wet compress were ordered to be kept on the tumor, and perfect quiet enjoined. The amount of food was restricted—fluids withheld as far as possible; there were prescribed ten drops of the tincture of digitalis every three hours, and one-fourth of a grain of the sulphate of morphia at night.

"*21st.*—Pulse 104. He passed a comfortable night. Pulsation of the tumor is more marked than after the operation, but not to the degree that obtained before, and the thrill was less distinct. Eight ounces of blood were taken from the arm—other treatment unchanged.

"*22d.*—Nine A. M., pulse 100; comfortable. At nine A. M. his pulse began to increase in frequency, and he complained of faintness. Wine was administered, but these unpleasant symptoms continued till I saw him at three P. M., when I found him much excited and nervous, with a pulse that could hardly be detected at the wrist, and with a fluttering heart. Fifteen drops of the digitalis with wine were given at once, and ten drops ordered to be repeated every hour, after which he quickly returned to his former condition.

"*25th.*—Pulse 98, less than for weeks; feels better every way, though weak from confinement and restricted diet. The operation was repeated as before. Eleven elements were used, the current allowed to flow fifty minutes. The immediate results were the same as before, but more marked, all pulsation in the tumor being arrested for the time, though it partially returned during the following twenty-four hours.

"*March 2d.*—Electrolysis was again repeated, the patient taking ether, which Dr. J. O. Stone was kind enough to administer. The number of elements was increased to fifteen, and the time to sixty minutes. The following gentlemen witnessed one or more of these operations: Drs. Markoe, Stone, Bumstead, Sass, Farnham, Noyes, Burrall, Sturgiss, Goodwillie, and Stevens.

"Circumstances rendered it necessary for the patient to leave the city, though further repetitions of the electrolysis were advised, and arrangements were made to have this done, and the principles of this method of treatment carried out after leaving the city.

"On the 9th of March, when I last saw him, his condition, compared with that before treatment began, was as follows: I could not discover that the tumor had increased in size; its pulsation, thrill, and murmur, were much less distinct, and its fluid contents evidently contained within a thicker and firmer wall. The pulse, which before the operation averaged 112, was reduced to 90 per minute. The pain in the shoulders, though still considerable, was much less acute and more bearable, so that he was able to get more sleep at night. There was no injury to the integument from the needles, their insulation acting perfectly satisfactorily, all the inflammation at the points of introduction and its neighborhood having entirely subsided before the next operation."

Cirsoid aneurisms which consist of a congeries of enlarged veins and arteries have been successfully treated by Meyer.[1] Varicose veins have also been treated, but unsuccessfully in most cases. The operation is sometimes indicated in varicocele. Schuch operated upon four cases of varicose veins, but not till after thirteen applications was a cure slowly effected. Malgaigne treated a young girl, who suffered with an aggravated case of this kind, with perfect success. There is no danger of phlebitis. The current should be passed through the positive needle into the enlarged vein, and the sponge-covered negative plate should be held upon the skin at a distance. Several operations are usually necessary; and, to obviate the trouble of an anæsthetic by the lungs, the spray-producer may be used.

THE ELECTROLYTIC TREATMENT OF TUMORS.

The use of electricity is rather a *dernier ressort* in malignant growths, although cases have been related by various authors attesting its success. Dr. Neftel has cured several patients, but it is difficult to see how galvanism actually *neutralizes* (as it is claimed) cancerous matter, and removes all traces of its malignant nature. Dr. Neftel[1] reports a case in the *Medical Record*, which is as follows:

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[1] Meyer, p. 469.

The tumor had been removed twice before the operation by electrolysis. The last time it reappeared, it attained the size of an orange before the patient came under Dr. Neftel's charge. The tumor was found to be carcinomatous by the microscope. The operation was performed three times, with ten, twenty, and thirty elements, and *séances* lasting two, five, and ten minutes. After the operation, the tumor was much larger and softer than before. It gradually began to disappear till the end of the second month, when no vestiges of the original growth were seen. There was no return of the tumor.

Dr. A. Jacobi and others have had cases that have recovered. Dr. J. Sinclair Holden,[2] physician to Lorne Union Hospital, London, reports an unsuccessful operation upon a recurrent fibroid tumor. The patient, a young woman, had a malignant tumor occupying the infra-spinal portion of the scapula. It had begun to press upon the trachea, as it involved the entire side of the neck. Dr. Holden used Smee's battery with six cells; four needles were introduced, two positive and two negative. The current (continuous) was applied three times a week for the space of a quarter of an hour. The result was that the part acted upon decreased in growth, and the surrounding parts grew rapidly.

Faradization may be used as a local anæsthetic in cases of scirrhus. If it is applied about the diseased parts, much comfort can be given to the patient. Erectile tumors yield readily to electrolysis. Dr. Sass, of New York, had a most remarkable case, which he treated with the greatest success. The patient was a prominent officer in the United States Army, aged thirty-three, and suffered from a small erectile tumor situated on the left side of the neck, in the antero-inferior portion of the region defined by the sterno-cleido-mastoid and trapezius muscles, and the clavicle. This appeared six weeks after an unusual strain upon the voice, and, when seen by Drs. Sims, Sass, and R. P. Lincoln, annoyed the patient terribly, as its pressure upon the trachea greatly interfered with respiration. Any cause, such as indigestion, active exercise, and mental excitement, would increase its size notably. On the 30th of September, 1870, the patient was anæsthetized, and four gilded steel needles were introduced into the four quarters of the tumor—the two upper being one and one-fourth inch apart, and one inch above the lower, which were one inch apart. The two inner were connected with the cathode, and the two outer with the anode. Ten, then fifteen elements of Stöhrer's battery were used. The strength of the current was gradually increased. At the end of fifteen minutes the two lower needles were removed, thus concentrating the force of the current on the two upper.

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[1] *Medical Record*, September 1, 1869.

[2] *British Medical Journal*, March 16, 1872, p. 287.

During the operation the prominence of the tumor disappeared, and was substituted by a hard mass. The skin over the tumor presented a bright blush, and the trachea had returned to its proper place. The patient kept quiet for three days, and kept a cold-water compress to his throat.

October 24th.—The tumor was diminishing in size, and the patient was entirely well.[1]

Nævi have been treated in this way, but a better means for their removal is the galvano-cautery.

I have personally witnessed the good effects following electrolyzation of goitres. Althaus speaks very encouragingly of this treatment. Of course, the treatment must occupy a long time, and we must have patience. The case which follows, however, is an exception to this rule, as the period between the first application and the last, when the patient's condition was so remarkably ameliorated, was very short:

I. L. T., aged fifty-two; Westphalia. I first saw the patient on March 20, 1872, when she presented herself with the following history: She had been in this country thirty years, and ten years ago a swelling appeared in the anterior part of her neck; this increased, growing higher and larger, and interfering with deglutition and respiration. On examination I found a large goitre, the skin over which was tense and glazed. This tumor occupied the entire anterior part of the neck, and measured, at its largest circumference, fifteen and a quarter inches. The weight of the patient was one hundred and twenty pounds, her height, five feet five and a quarter inches. Galvanism was applied by means of two moistened sponges placed on either side. The current, from forty cells, was transmitted for a period of twenty minutes. During the *séance* the tumor became large and very red, and a severe coughing fit was produced.

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[1] The facts of the above case I have taken from Beard and Rockwell's "Medical and Surgical Electricity," p. 656.

March 23*d*.—Patient breathes more easily. Thirty cells.

28*th*.—Thirty cells. Tumor has decreased three-fourths of an inch.

April 4*th*.—Tumor measures fourteen inches. After the last visit she had pain, with difficulty of respiration. Forty cells.

6*th*.—Goitre measures thirteen and three-quarter inches. Forty cells.

11*th*.—Deformity much less. Patient desires to discontinue treatment.

November.—Patient seen four months afterward; no subsequent growth of the tumor.

M. Groh has made a series of experiments with differently-constructed batteries. He finds that strong currents are best adapted for those cases in which it is desirable that rapid destruction should be effected, as in carcinoma; but for the treatment of small tumors, and where the object is to produce coagulation, those batteries should be used which consist of a small number of small plates. The pain accompanying the operation increases with the number of the elements. In the first series of cases he reports that he treated six patients in twelve sittings with the electrolytic current. None of these patients were narcotized, and the pain was found to be supportable up to twenty elements. One of them was a man, aged thirty-nine, with hydro-sarcocele. Immediately after the application, considerable diminution of the consistence of the tumor was observed; and after four days it had diminished one-half. He has used electrolysis in various modes: with strong currents applied for a short time, and with weak currents for a longer period; the former in cases of angioma, hæmorrhoids or swellings, scrofulous lupus, condylomata, and sarcoma, and in all instances with good results. The application of weak currents he thinks deserving of much more extended trial, as it has answered capitally in his hands.

Pulvermacher's chains, and Garrat's metallic disks, may be worn over or about some tumors, with the effect of sometimes reducing them. I doubt if the galvanic action from these instruments would be sufficient to accomplish any great reduction in the size of the growth.

THE ELECTROLYZATION OF SEROUS TUMORS, ETC.

Passing over the special consideration of encysted tumors with a word—and that is, that, besides affecting absorption, the constant current creates an adhesive inflammation of the sac-wall—we will discuss its merits in hydrocele. The older writers, who treated these effusions by the introduction of a canula and rough wire, were more apt to cure the patient by the irritation and inflammation produced by their instruments than by the electric current. Althaus recommends that an insulated needle connected with the negative pole be introduced fairly into the cavity of the tunica vaginalis, and the positive sponge should be applied exteriorly. The current should be passed for from five to seven minutes. One application is usually sufficient. If the faradic current is employed, three or four operations are required. The galvanic current should be employed. I append a case treated by Dr. Alexander Murray, of this city:

"John McCaffrey, aged forty years, ship-carpenter, applied to me on the 17th of August, 1869, for treatment of a hydrocele of the right side of the scrotum. He stated that two years ago, while at work in a ship-yard, he was struck accidentally with a piece of wood on the testicle. Inflammation followed. About four months before I saw the man, he noticed that the scrotum grew larger and softer, and caused a dragging pain in the side.

"I tapped this hydrocele seven times in eighteen months, the quantity of fluid drawn off varying, at each operation, from twenty-seven ounces to seventeen ounces. He was unwilling to submit to any operation for a radical cure, lest he might lose the proceeds of a few days' work. He wore a suspensory bandage to support the scrotum. On the 9th of May, 1871, I introduced a trocar and canula for the eighth tapping, withdrew the trocar, and, before any quantity of the fluid had escaped from the sac, I inserted a platina wire as large as the trocar, connecting it with the negative pole of the galvanic battery, and, with the positive sponge-electrode over the scrotum, I employed a current, gradually increasing it until it produced pain. After thirty minutes I allowed the accumulated fluid (seventeen ounces) to run off, and then continued the use of the current for five minutes longer.

"More than six months have elapsed, and I find upon examination that there has been no reaccumulation of fluid, and that the right side of the scrotum is only a little larger than the left, with no sensation of weight or pain. There was but slight œdema for two days after the operation."

Dr. Dittle[1] treated a hydrocele, which was benefited after three applications, each lasting fifteen minutes (the positive twice and the negative once in the tumor), so much that it was diminished to one-quarter its former volume; the tunica vaginalis became hard and tough, and the tumor lost its transparency. This gentleman also experimented with *varicose veins* of the leg according to the same method, and had the result that contraction of the vessel to a hardened cord, and all subjective symptoms, disappeared. A *varicocele*, enormous in size, was contracted, after one introduction of four needles (attached to the platina-pole), to such dimensions that, after three weeks, the veins had the appearance of empty, hard, tough cords, and soon after followed by entire disappearance of the disease.

Hydatids.—Drs. Fagge and Durham, and Dr. Forster, of London, have operated upon eight cases of hydatids in the manner described by Althaus in his treatise "On the Electrolytic Treatment of Tumors." The two former gentlemen presented a paper on the subject, at a meeting of the Royal Medico-Chirurgical Society. In each case two needles were passed into the tumor, and were connected with the negative pole of a battery of ten cells. The positive pole, terminating in a moistened sponge, was placed upon the surface of the abdomen. The current was allowed to pass for a period varying from ten to twenty minutes in different cases. The needles were then withdrawn. A little clear fluid in some cases appeared at the seat of the punctures.

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[1] "Beiträge zur electrolytischen Behandlung," *Oestr. Zeitschr. f. pract. Heilkunde*, Nos. 17, 18, 1868.

No preliminary tapping nor exploratory puncture was made in any case. The diagnosis rested on the facts that the patient had a rounded, elastic tumor projecting from the liver, and that this was *cystic*, as proved by the needles rubbing freely against one another in its interior, although introduced an inch or two apart.

The operation was followed in most cases by rapid diminution of the tumor, which, even shortly after the operation, became soft and flaccid. At the same time, in some cases, fluctuation became perceptible in the lower part of the abdomen.

Slight febrile symptoms, and more or less pain, in most cases followed the operation; these symptoms, however, rarely lasted more than three or four days. In one instance they were entirely absent. In most cases the patients were able to get about in a few days, and some of them were discharged from the hospital at the end of two or three weeks. Even at this early period the tumor had already, in some cases, very manifestly decreased in size; and, as a rule, this decrease, when once it had fairly commenced, steadily progressed. After the lapse of six months or a year, when each patient returned for examination, no trace of the disease remained; or, at most, there was only some ill-defined fulness of the epigastrium.

In one case only the result still remained doubtful. In the remaining seven cases the favorable issue above described had already taken place. All the patients were in perfect health.

In the latter part of the paper the results of electrolysis are compared with those of simple tapping—the operation which has hitherto been most successful in the cure of hydatid diseases of the liver. The authors claim for electrolysis that it rivals simple tapping in being unattended with immediate danger to the life of the patient, and that it is to be preferred, inasmuch as (according to their experience up to the present time) it involves no danger of suppuration within the cyst, and consequent risk and suffering—results which often follow simple tapping.

ELECTROLYSIS OF STRICTURES.

The operation of electrolysis in stricture of the urethra has been the subject of much controversy among medical writers. Mallez and Tripier have operated most successfully in many cases, and up to the year 1870 had performed thirty-one cures. Dr. Keyes,[1] of this city, discourages the operation. He passed an instrument of his own construction upon the patients without doing any good. Dr. Keyes recites his experience, states his cases, and convinces the reader that he has most carefully investigated the subject.

The theory of the electrolysis of stricture is this: The slough produced where the negative pole touches is such as that produced by an alkaline caustic, and the cicatrix is soft and non-contractile. At the positive pole the cicatrix is retractile, like that left by a burn or an acid. An instrument insulated to its end, where it terminates in an olive-pointed bulb, is connected with one pole (the positive), and passed into the urethra till it reaches the stricture. The other pole (negative) is held against some part of the body in the neighborhood. Mallez and Tripier say that one operation is sufficient. Dr. Keyes's conclusions are as follows: "Organic strictures may be widened by the passage of the negative current. Recontraction takes place after this, as after all other methods (Mallez and Tripier to the contrary). Sometimes the urethra becomes continuously wider at the constricted portion. The operation is painful, and vesical symptoms are aggravated where they exist."

From my own experience I find that the only beneficial results that follow the use of electricity in these cases are those that occur when the current is very mild (not so strong as to produce sloughs or cicatrices). A mild current undoubtedly has an electrolytic effect which will eventually enlarge the point of stricture.

Dr. Robert Neumann[2] has treated several cases of stricture successfully; but, as two agents, galvanism and laminaria digitata, were used, we are left in the dark as to what virtue galvanism actually had.

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[1] "Practical Electro-Therapeutics," *New York Medical Journal*, December, 1871, p. 587.

[2] *Medical Record*, July 1, 1872.

GALVANO-THERAPEUTICS OF WOUNDS AND ULCERS.

We shall find that, when electric stimulation of a slowly-healing wound or ulceration is made, a most remarkable change in the appearance and behavior of the part will occur. Granulation will spring up, and a cicatrix as quickly form. So striking is the above experiment that, if systematic galvanic stimulation of an ulcer be made, it will heal in a very few days. In old indolent ulcers this treatment is far preferable to all others. We may either apply the faradic or galvanic currents by means of a metallic plate (zinc is preferred), or we may adjust permanently a plate of silver to the surface of the ulcer, and a plate of zinc to some adjacent point on the healthy skin. These should be connected by a wire soldered to both. The perspiration from the skin beneath the upper plate, and the moisture upon the surface of the ulcer, will generate a feeble galvanic current. These plates may be fastened in place by adhesive straps, but the surface of the sore should be watched from day to day to moderate the action.

Dr. Alexander Murray reports the following case: "A man, aged thirty, with seven ulcers upon the lower third of the right leg, applied to me for treatment during the month of October instant. These ulcers were of two years' standing, and, as the case appeared to me to be one favorable for testing the relative merits of the poles, the size and condition of each ulcer being as nearly as possible uniform, I selected four for treatment by the positive and three by the negative pole. I first cleansed the sores with a piece of sponge wet with a weak solution of chlorinated soda, and having *partially* dried them I applied the flat-disk electrode. I applied the galvanic current as strong as could be borne to each ulcer, for the space of five minutes, occasionally wiping away any discharge. This treatment was repeated every third day. In two weeks the healing process, in the four under the influence of the positive pole, was considerably in advance of that of the three under that of the negative."

I have galvanized indolent buboes, and have induced granulations and final closure of the wound in a very short time. Dr. G. K. Smith,[1] of Brooklyn, and Dr. Snively, of the same city, have both treated slowly-healing stumps after amputation.

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[1] Beard and Rockwell, "Medical Electricity," p. 661.

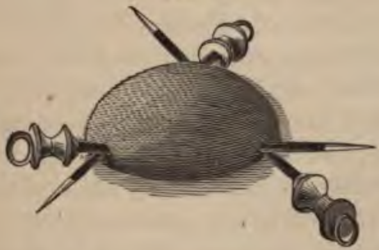
Cicatrices, Anchylosis, etc.—In the *Centralblatt für die Med. Wissen.*, lately, Dr. M. Meyer gave his experience on the effect of galvanism on scars, contractions, and anchylosis. If the positive pole is placed on the scar in the muscle, with the negative pole on the opposite side of the bone or on the muscle at some distance off, a remarkable softening of the scar takes place; by means of a frequent repetition of this operation for the space of three or five minutes, with a current only perceptible, but painless, the exudation disappears, and the skin of the scar becomes pliant and of normal color. Contractions caused by immovable bands very quickly yield to the positive pole; those caused by muscular or tendonous scars disappear, by gradual softening of the scars; those caused by contusion of a nerve, and for the most part accompanied by anæsthesia of the skin, give way most rapidly by the following method: the negative pole is held to the anæsthetized skin, while the scar and contraction are touched with the positive pole. The swellings in the bones which are caused by the entrance of bullets very quickly go down, and often in a few minutes a marked and visible swelling may be influenced, while chronic nodes and scrofulous swellings of bones, again, only very gradually are lessened in size. In one case, the right median nerve was injured one inch below the axilla, the palm of the hand was without sensation, the upper arm could be raised only with great difficulty. In six weeks the patient was cured; could raise the arm easily, and shut the last three fingers. The ring-finger alone was stiff, and its skin without sensation; the thumb, too, a little constrained in its motion, and the pressure of the hand still weak.

THE ELECTRIC TREATMENT OF NÆVUS, ETC.

When we meet with those bluish-red spots which are commonly termed "birth-marks," we may remove them, if they are not too large, by the application of the negative pole. If, however, we find that they are raised above the level of the skin, and are purely nævi maternus, we must use a more severe method. We may then introduce into their substance two or more wires connected with a galvanic battery, and pass a strong current. The rapid evolution of hydrogen at the negative pole will be followed by disintegration of the growth by the mechanical pressure of numerous bubbles of this gas. The best results I have had were those following a heated condition of the wires or needles. Many operators make this distinctly one of galvano-causty. I have used a platinum needle, which is quite flexible; this is attached to a steel point, and the growth literally sewed. When the wire is passed through the growth, I attach the two cords of a powerful galvanic battery (usually a galvano-causty battery) to either end by small clamps. The wire immediately becomes red-hot. I make several punctures of this kind.

Dr. Alexander Murray,[1] when performing the operation of electrolysis upon a nævus, introduces the needles in the manner depicted in Fig. 48. Dr. Murray has been unusually successful in his treatment of these cases.

FIG. 48.



Foreign literature is very prolific in statistics of this operation. Dr. Maas, of Breslau, has collected[2] the histories of one hundred and twelve cases of nævus treated by the galvanic cautery. The results were as follows: Capillary nævus—cured, thirty-two; improved, one; result unknown, one. Cavernous or venous nævus—cured, seventy-two; improved, eight; result unknown, one; died, three. Arterial nævus—cured, two; improved, one. Nævus combined with other tumors—cured, six; improved, one; result unknown, two. He derives from the examination of the cases the conclusion that the galvanic cautery is followed by the best results in nævus, and is much safer than the injection of perchloride of iron or any other coagulating fluid. It would, however, be wrong to say positively that the remedy is indicated in all cases of nævus. The surgeon must take the circumstances of each case into consideration.

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[1] *New York Medical Record*, November 1, 1872.

[2] *Archiv für klinisches Chirurgie*, vol. xii.

CHAPTER XII.

GALVANO-CAUSTY, ETC.

Batteries, Electrodes, etc.—The Operation.—Cases.—Miscellaneous Uses of Electricity.—Electric Baths.—Absorption of Inflammatory Products.—Spermatorrhœa. — Orthopraxy.—Vomiting of Pregnancy. — Detection of Metallic Substances.—Carbuncles and Furuncles, etc., etc.

The applicability of this process in many cases when the knife is impracticable, and its advantages over that instrument in certain instances, recommend it at once as a most valuable surgical means. Galvano-causty has been used lately in this country by the gynæcologists to a great extent, and abroad by other specialists in very many surgical diseases. The operations for which it is specially indicated are the following:

Removal of polypi, pediculated tumors, etc.

Removal of cancerous masses from the cervix uteri and other localities.

Removal of hæmorrhoids.

The division of sinuses and fistulæ.

Cauterization of diseased surfaces.

Cauterization of the vaginal walls for the purpose of causing cicatricial contraction.

Cauterization of ulcers.

Amputation of the cervix uteri, etc.

The advantages of galvano-causty are evident. Its use is attended by no hæmorrhage, the parts acted upon being cauterized most effectually. The cautery may be introduced in a cold state, and, when the instruments are adjusted, the operation performed, and the cautery withdrawn, without any injury to the adjacent parts. It can be used in places where the employment of the knife would be inconvenient or impossible.

The operation is comparatively painless; there is no shock to speak of, and thus the danger is reduced to a minimum.

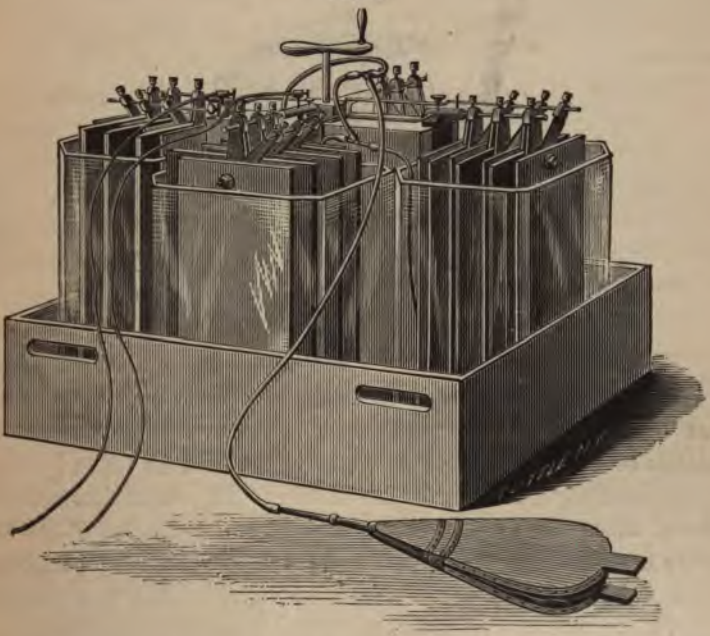
There is very seldom any occasion for the use of the ligature or torsion; there is consequently no hæmorrhage. These advantages recommend it most highly.

The *rationale* of galvano-causty is this: When a poor conductor of the electric current is placed between two good ones, and a current of quantity is sent through them, the poor conductor, from its inability to transmit the great amount of electric fluid, will immediately undergo a rapid increase of temperature.

Platinum is used as the resisting part of the circuit, and with a proper current it will become first red and then white hot. Certain conditions govern the selection of the cauterizing wire, and these are—1. That it should be small and short. A large wire will require a greater current to raise its temperature than a small one. 2. The wire should always be platinum, as the other metals easily melt.

Galvano-Causty Batteries.—The German surgeons are in the habit of using Middeldorpf's, Grenet's, and Bunsen's batteries. Most of these are inconvenient from the fact that it is troublesome to remove the plate from the solution after use, and that these foreign batteries are cumbersome and bulky. A galvano-causty battery must furnish a "quantity-current," and this can only be done by the use of large plates, and by condensation of the poles; that is to say, the negative poles of the several batteries should all be joined together, and the positive poles should be united in the same way, instead of one element, electro-positive, being joined with another, electro-negative, and so on through the series, as is the arrangement in the batteries giving "intensity-currents." When all the elements of one kind, and all of another, are joined as I have just described, we have but two large plates, so to speak, and thus get a very powerful quantity current. The instruments of the Galvano-Faradic Company of New York (Fig. 49) are most excellent; they are a greatly-improved modification of Stöhrer's. By a screw on top, we are enabled to get a gradual increase of current, thus immersing the plates, or removing them entirely. When I spoke of polarization, I mentioned the fact that numerous small local currents were apt to generate upon the surface of the plates, also that the negative plate would be eventually covered by so many bubbles of the hydrogen gas that the strength of the current would be diminished. This condition is fatal to a uniform strength of current, and, as this is desirable in galvano-causty, we require some remedy for the evil. To most of the batteries, therefore, are attached a pair of bellows which can be worked by an assistant. A current of air from these passes into the exciting solution of the battery, and prevents the accumulation of gas upon the carbon-plate. I have used a battery made for me by Mr. Chester, of this city, and also a series of twenty Grove's cells, but consider the Galvano-Faradic Company's battery much better than either of them.

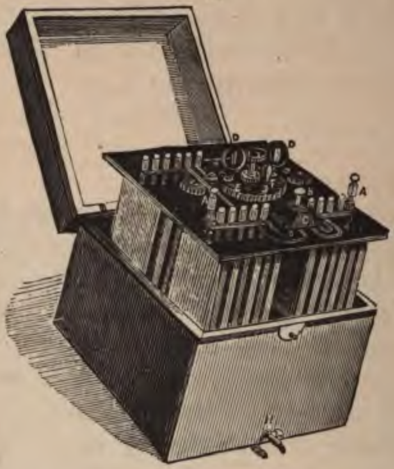
FIG. 49.



Mr. Jerome Kidder, of New York, makes a galvano-causty battery which Drs. Beard and Rockwell speak very highly of.

Fig. 50 represents Dr. Byrne's battery. The merits of this instrument is its ready portability. As a piece of workmanship it is delicate and beautiful, its great defect being that the zinc plates are so very thin that they are rapidly eaten up by the solution in which they are immersed. I had the pleasure of witnessing the duty this little battery can perform, at a recent operation by Dr. Sims, at the Woman's Hospital. It consists of twelve carbons and twelve zincs, each three by five inches, combined and arranged so as to represent four sets or cells of three pairs each. In this order the elements are securely fastened by nuts and screws to a hard-rubber platform seven and a half by eight inches in surface, and one-quarter inch thick; and the combinations and connections effected by means of narrow strips of copper annealed and nickel-plated.

FIG. 50.



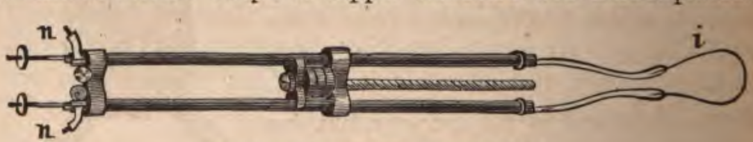


FIG. 51.—Dr. Byrne's Galvano-Causty Loop.[1]

In the centre is a cog-wheel three inches in diameter, which, on being turned by means of upright handles, causes the two water-agitators to revolve. The object of this arrangement is

[1] All of Dr. Byrne's instruments are made by Messrs. Shepherd & Dudley, N. Y.

to increase the power of the battery, when, owing to continued use, as in tedious operations, the fluid may become exhausted.

Instruments.—Stöhrer, of Dresden, sent to this country the first galvano-causty electrodes that were used here. Since their arrival, numerous improvements have been made. The instruments used may be divided into three classes, and these have subdivisions. They are:

1. The loop.
2. The cauterizing knife.
3. The porcelain, or dome cautery.

1. *The loop*, which is constructed on the principle I have alluded to before, is simply a piece of fine platinum wire passing through supports, and, after being doubled, is attached to a non-conducting barrel, which is made to revolve at the will of the operator, thus shortening its length, and finally reducing it altogether, if desired. A handle containing an arrangement for breaking the circuit is adjusted to the supports or tubes through which the wires pass.

Stöhrer makes an instrument so cumbersome that it is exceedingly clumsy to work with.[1] At my suggestion, Mr. Bartlett, of the Galvano-Faradic Company, made me, after a sketch I gave him, an electrode which I have used several times with success. Its weight is but a few ounces, and it is simply and entirely under the command of the operator, but one hand being required for its manipulation.

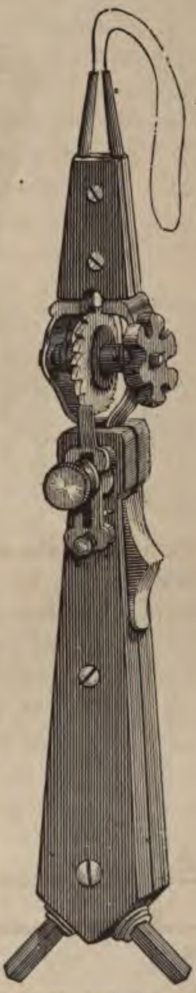


Fig. 52.—The Author's Galvano-Causty Electrode.

Fig. 52 represents the electrode I have just mentioned. It consists of a barrel regulated by a ratchet; two tubes, a handle, and a slide for breaking the current. The loop of platinum wire passes through these tubes and may be moved upon the barrel, thus reducing its diameter. These are made of different shapes; either large, for the greater operations, or long and narrow, for the removal of tumors in the larynx, or operations in the vagina.

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[1] Since writing this, I have heard of a most excellent electrode devised by Dr. B. F. Dawson, of this city.

2. *The cauterizing knife* is but a flat plate of platinum, which, when incandescent, may be used to divide the soft parts. It is also made in many shapes.

3. *The Porcelain, or Dome Cautery.*—The spiral adjustment of a piece of platinum wire immediately to the surface of a cone of thin porcelain will result in the heating of the porcelain by the wire when the current is passed. They are of numerous shapes and sizes, in accordance with the surface of the part to be operated upon. The cauterizer may be used in all cases when it is our desire to arrest hæmorrhage.

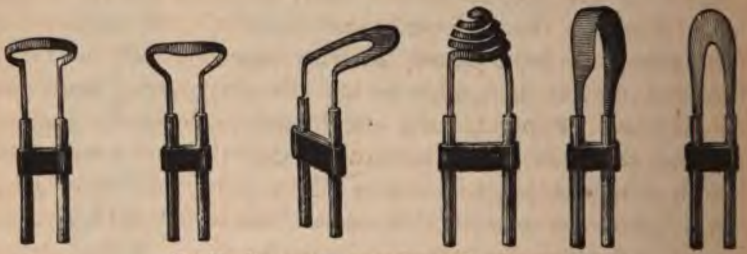

FIG. 53.—VARIOUS GALVANO-CAUSTY ELECTRODES.
(From a recent article, by Dr. Byrne, in the *Medical Record.*)

In operating, we should first see that our connections are all perfect, and that the battery is freshly charged. Then we should test the *severance power* upon a piece of raw meat. If the juices of the meat lower the temperature of the wire too greatly, a turn or two of the handle which immerses the plates will increase the quantity of the current; when the wire is brought to a *white*, not a red heat (for with the latter the wire tears off pieces of tissue, and makes a ragged cut, opening the mouths of the vessels, thus producing hæmorrhage), we may break the current and prepare for the operation in hand. The wire should be adjusted about the neck of the tumor, or the most convenient place, and, after the wire is wound upon the barrel till the part is tightly constricted, the slide is moved and the current turned on. Gentle traction is then made, and the growth removed. The slide is to be immediately closed, or the wire will be melted. Very little after-treatment is to be observed. Cold-water dressings, and attention to the patient's general condition, are all that are necessary.

The heat of the wire must be gauged to *incandescence*, and the operation quickly performed, otherwise the slow passage of the wire through the tissues will produce a diffused inflammation. When the eschar comes away, we may treat the denuded surface as we would any other case of simple ulceration.

The cases I have treated have been of inconsiderable importance. I append one or two, however:

I. Dr. G. The patient presented himself with a small, hard tumor on his right shoulder. After placing a piece of moistened linen on the part perforated, to permit the exposure of the entire tumor, I passed the wire loop about the most constricted portion, and, after taking the preparatory steps just mentioned, I completed the circuit and made gentle traction on the wire. In half a minute the growth came away, without a drop of blood to be seen. The eschar was of an ashy-gray color. In a week this eschar became detached, and beneath I found a healthy granulating surface. A few straps, and stimulating ointment quickly healed the part.

II. E. T., aged twenty-five. The patient came to me with a small complete fistula, very near the verge of the anus. One end of the wire was detached from the barrel and passed by an eyed probe through the fistula into the rectum. It was then brought down, passed through the tube, and fastened to the barrel; after the loop was tightened, the circuit was closed and the tissues divided. The after-management of the case was that usually employed in this operation, by the knife. The tardy separation of the slough enabled the cavity of the abscess to fill up to a great extent before the bare surfaces of the cut portion were exposed. Consequently there was not the usual disposition of the wound to close by primary adhesion. One advantage of this use of the galvano-causty in this case depended upon the fact that the patient had a "holy horror" of the knife.

Dr. A. Murray, of New York, performed the operation upon a patient of his in a different way, as the following case will show:

III. In August, 1871, John Connor, who, for nearly eighteen months, had been suffering from a *fistula in ano*, applied to me for treatment, requesting a cure if possible without a surgical operation. I introduced a small probe of platina wire into the fistulous canal, and a wooden scoop into the rectum as a *point d'appui* for the extremity of the probe. During the operation, a galvanic current of sixteen cells, steadily increased, was allowed to pass for fifteen minutes. The battery having been freshly filled that day, the probe became heated so rapidly that I was compelled to desist from the application sooner than I had wished. However, I was gratified to find that, at the expiration of five days, the fistula had entirely healed.

IV. Dr. Corradi[1] lately removed a large tumor (fibrous polypus) from the pharynx of a man who for a year had been unable to pass air through the nostrils. The tumor, when removed, measured forty-eight millimetres long, by twenty-eight wide, and was of oval form. The base of the tumor adhered to the pharynx. The tumor was surrounded by the loop of platinum wire fifty-eight centimetres long, the two ends of which were brought out of the right nostril. After seeing that the wire was closely brought up to the base of the tumor, the two ends of it were attached to the extremities of a galvano-caustic apparatus. The tumor was rapidly cut through, and the patient did well.

The following cures were reported recently by Dr. Thomas Bryant, of London:

V. *Cutaneous Nævus over Chest.*—Alice C., aged four months. Nævus involving the skin on the left side of the chest, the size of a crown-piece. On January 8, 1869, it was cauterized deeply with the porcelain cautery, and brought to a white heat by a coil of platinum wire. The whole growth was completely destroyed, and in two weeks, when the eschar had separated, perfect cicatrization had taken place.

VI. *Cutaneous Nævus over Forehead.*—Agnes W., aged four months. Superficial nævus over right frontal eminence, the size of a shilling. On October 30, 1868, the cautery was freely applied, not a stain of blood showing itself. A brown eschar was left; in two weeks this came away, and the parts had healed, a perfect and movable cicatrix remaining.

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[1] "Lo Sperimentale," 1871.

VII. *Mixed Nævus over Forehead.*—Robert C., aged sixteen months. Mixed nævus, the size of a shilling, on the right side of the forehead; it was very elevated and spongy. Mr. Bryant cauterized this superficially, at first turning it into a brown eschar, and then puncturing it with another form of platinum cautery, the object of this being to destroy the deeper parts of the growth. In two weeks the whole dried scab came off, and a sound healing surface remained. In another week the cure was complete.

VIII. *Spreading Lupus of the Face, cured by the Cautery.*—Eliza T., aged thirty, came under Mr. Bryant's care with a spreading lupus, involving the whole of the nose and upper lip. It had existed for four years, and, in spite of all treatment, had steadily progressed. On November 6, 1868, it was freely cauterized. By the 19th the scab was coming away, a healing surface remaining. By the 26th the whole eschar had fallen off, and the wound was closing. By December 8th the woman was well. She was seen on April 10th, when it was difficult to make out the seat of the former disease, the cicatrices being so indistinct, and the skin natural.

Dr. Byrne, of Brooklyn, and Dr. Marion Sims, of this city, have both operated upon women with galvano-causty in a great number of instances with remarkable success.

Mr. Elliot,[1] of London, gives the operation for prolapsus, as follows: "A glass speculum coated with caoutchouc is first introduced into the vagina. The os is then cleaned with a piece of cotton-wool; the cautery next heated is allowed to be quenched by the diseased tissue, the duration of the application, and the depth of introduction, depending upon the effect required. Eschars are easily produced, and the cervix uteri is seen to contract under the application of the cautery.

"It is never advisable to use a metallic speculum, for the interior heat is apt to be radiated to such a degree that absolute burning of the vaginal walls may ensue. The wax or caoutchouc-covered glass ones are the best. Pledgets of wet lint should be spread about the exposed surfaces. These simple precautions go far to insure the safety of the operation."

Dr. Byrne, of Brooklyn, gives the following case:

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[1] London *Lancet*, 1853, vol. i.

IX. *Carcinoma of the Uterus, involving both Lower and Supra-Vaginal Portions of the Organs.*[1]—Mrs. ——, aged forty-seven, the mother of three children, the youngest being ten years of age. Since her last confinement, and up to three years ago, menstruation has always been regular; but, about this time, symptoms such as usually indicate the approach of the critical period of life began to appear. Menstruation became at first irregular, but, for over a year, had lost all the character of periodicity normal to that function, and copious hæmorrhages had now reduced her to a perfectly helpless condition. By a digital examination, the vaginal cervix was found to be hypertrophied and irregularly hard to the touch.

The os uteri admitted, with some difficulty, the index-finger to the extent of about half an inch, and the surrounding tissues, as far as could be reached, were unyielding and indurated. Owing to the peculiar shape of the outgrowth within the vagina, and the absence of any circular line of depression near the uteri-vaginal point of convergence, it was very evident that the adjustment of an *écraseur* cautery loop would be impracticable. The difficulty arising from this state of things, though not encountered in any of the doctor's previous cases, was, nevertheless, provided for. An anæsthetic having been administered, and the patient placed on the table, there was no difficulty found in bringing the uterus into such a position that full control and ample space were afforded for any manipulation needed. The gentlemen present at the operation were Drs. G. K. Smith, Skeene, Dwyer, and Bedell.

The projecting mass was seized by means of a vulsellum forceps held in the left hand, while, with a cautery-knife of peculiar construction, the part so grasped was slowly severed, and removed without loss of blood. The same knife, but bent in a semicircular form, was now applied to the subjacent structures, which were cautiously sliced off, piece by piece, upward as well as laterally, to the utmost extent compatible with the integrity of the peritoneal surroundings. When the organ was thus scooped out, a deep cavity was left, from the bottom of which to the fundus measured less than one inch. No hæmorrhage occurred during the whole operation.

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[1] *American Journal of Obstetrics*, August, 1871, p. 296.

A subsequent examination revealed an utter absence of indurated tissue; of course, nothing is found resembling a cervix or uterus. The vaginal canal terminates in a deep *cul-de-sac*, the interior of which seems to be completely healed and covered by a healthy membrane. It is also worthy of notice that in the natural process of reparation a good deal of contraction has taken place, but the opening is neither puckered, nor does it offer the slightest resistance to dilatation by separating the blades of a polypus-forceps. The patient has a good appetite, is free from pain, and sleeps well. She may be pronounced convalescent and out of danger.

Dr. B. has also operated upon, and satisfactorily removed, a very large fibroid polypus in a woman of thirty. It appeared the third day after labor, and, owing to the size and history, was at first mistaken for an inverted uterus. The attachment was to the posterior lip of the cervix. Removed by the galvanic loop. He has also removed elongated cervici, cauliflower cancer of the uterus, etc., etc.

In numerous minor operations it has been successful in my hands. I have, on more than one occasion, stopped obstinate hæmorrhage following the use of the knife.

Dr. Whittaker, of Cincinnati, contributes the following case to *The Clinic*:[1]

X. *Amputation of the Cervix.*—Mrs. B., aged twenty-eight, is still sterile, though married for several years and in fair physical condition. She has suffered with menstrual irregularities ever since marriage; dysmenorrhœal at times, in character, at times amenorrhœal, at times menorrhagic. She is of hysteric temperament. There are cervical hyperplasia to the extent of one inch; anteflexion, with pressure upon the bladder, and impermeability to the entrance of even the finest sound.

I proposed first to remove part of the cervix, subsequently to dilate and explore the uterine cavity.

Accordingly, she took rooms in the Hospital of the Good Samaritan, where the operation of amputation of the cervix by galvano-causty was undertaken the following day. She insisted upon chloroform, which we were compelled to administer. Having placed her in Sims's position, and brought her lightly under the influence of chloroform, a hard-rubber speculum was introduced, and the elongated cervix invaginated into its upper extremity.

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[1] *The Clinic*, September, 1872.

The apparatus having been prepared and tested upon a piece of meat by my friend and colleague Prof. Seely, with the assistance of Drs. Jones and Lockhart, house-physicians, in keeping the patient steady—all the assistance required—I slipped the noose over the cervix with the greatest ease, adjusted it smoothly about it, probably half an inch from its extremity, screwed the wire home and then touched the spring of connection with the battery. The progress of the wire, as it slowly tightened under the screw, was evidenced also by the sound, smoke, and savor of the *cuisine* from the rapidly-burning tissue. In perhaps one minute the operation was complete, and the ring of detached cervix fell from the tube. The uterine surface—the stump, so to speak—was perfectly white and clean. There escaped throughout, nor afterward, no single drop of blood. I then inserted a sponge-tent forthwith, which I was obliged to remove on the following day, however, on account of the supervention of the menses. Menstruation continued rather profuse for several days, yielding only finally to large doses of ergot. She had, during this period, suffered the usual pains. I was about to resume efforts at dilatation after the discharge had ceased, but the patient had already wearied of treatment, and left the house.

It was a matter of regret, of course, not to have been able to have followed up the case as I had proposed, but I was thankful for the opportunity of personal experience with the galvano-causty noose. It is an instrument which filled all the requirements in this case. I have since heard, indirectly, that the patient is doing well.

AMPUTATION OF THE PENIS.[1]

In Langenbeck's "Archiv," M. Zielewicz mentions fifty cases where the penis was operated on by a wire heated by galvanism. For the most, it was for carcinoma the operation was made use of. In one case there was a considerable papillary tumor, and in another gangrene. Eight of the fifty cases died of pyæmia; all of them were hospital cases. No hæmorrhage took place in any of the cases, nor was there ever any traumatic fever. The contraction after the operation, of the urethral orifice, was similar to what takes place after the knife. The ages of those operated on were known in forty-five cases. It was in one under 20; in six, between 30 and 40; in fifteen, between 40 and 50; in fifteen, between 50 and 60; and in seven between 60 and 70. Three cases occurred in old men between 70 and 80.

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[1] Reported in *The Doctor*, November 1, 1871.

GALVANO-CAUSTY IN HÆMORRHOIDS.

M. Verneuil, at the Lariboisière, has treated hæmorrhoids by running through them the electric-cautery needle at a dull-red heat, which obliterates the vessels without setting up active inflammation beyond. Atrophy follows. I myself have treated two or more cases in this way, when the hæmorrhoids were not aggravated. In another I removed a large mass of hæmorrhoids by the loop, without any inconvenience to the patient or any bleeding. It is well, in this operation, to protect the surrounding soft parts well with cotton saturated with water, and, after the parts to be removed are exposed, they should be quickly divided.

ELECTRO-CHEMICAL BATHS.

Several writers, among them Caplin, Meding, and M. Chapot-Duvert, have used the electro-chemical baths for the purpose of extracting metallic substances from the body. Verques[1] reports an interesting evidence of its virtue in extracting metals from his own body; and lately Dr. Murray,[2] of New York, has given his results in a number of the *New York Medical Journal*. Althaus[3] rather doubts its efficacy, and has but little faith in it. In rheumatism it is indicated, perhaps, but even then it would do more good if the electricity were applied locally and concentrated. The benefit it has as a general cutaneous stimulant cannot be denied, and therefore it is clearly indicated. M. Camille Chapot-Duvert describes[4] his apparatus thus: "It consists of a pair of Bunsen's elements of medium size, and a coil of large wire connected with a copper regulator which augments or diminishes the force of the apparatus by covering or uncovering a larger or smaller portion of the core, which serves to interrupt the current by means of a vibrator. The positive pole, formed of a large fragment of charcoal, corresponds to the pedal, and the negative, formed of a plate of zinc, to the cephalic extremity." We can modify this cumbersome apparatus by simply connecting an ordinary faradic instrument with two plates of metal; these are immersed in the bath, which should be made of varnished pine. The secondary current must be used. We employ this bath in cases of prolonged debauch, for the extraction of lead and other metals, and for mercurial trembling. "Mercurial tremor," Dr. Duvert says,[1] "is one of the most frequent manifestations of mercurial intoxication. Without causing any apprehension in respect to the life of the sufferer, it is a troublesome symptom for the workman who is obliged to gain his livelihood by the labor of his hands. The progress of the disease is slow, and it recurs frequently if the individual be exposed anew to the original cause of the affection. The measures usually employed consist in sudorifics, vapor and sulphur baths. Opium has also been recommended, but the treatment has always been excessively protracted, and has often proved unsuccessful. A mirror-maker, aged twenty-six, applied on the 12th of January, 1870, at the Hôpital St.-Louis; brought up as an agriculturist, he had been five years at the trade. Soon after commencing to work at it, he had the usual symptoms of mercurialism, but these were removed by treatment, and he remained well for two years. He then suffered a relapse, and was again cured. He was abstemious in regard to drink, and went on tolerably well to December, 1869. Then debility was experienced, followed by gradually-increasing tremor, for the relief of which he applied. The trembling was marked in both pairs of extremities, sensibility was intact, the muscular force was considerable. He was placed in the electric bath, and remained in it for twenty minutes, and this was repeated daily for seven days. Great improvement in the power of walking was experienced, and he could use his right hand to eat with. After twelve days' baths, the improvement was still more marked; he could run with facility and walk with an assured step, though on his admission he was so weak he could scarcely stand upright. After twenty baths he was perfectly well." M. Chapot-Duvert states that he has had equal success with the remedy in cases of alcoholic tremor. He was unable to discover that any traces of the metal in the former cases were discharged either by the urine or on the zinc plate.

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[1] Meyer's "Medical Electricity," p. 489.

[2] *New York Medical Journal*, November, 1872.

[3] "Medical Electricity," p. 658.

[4] London *Practitioner*, August, 1871, p. 115.

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[1] *Bulletin Général de Thérapeutique*, June 15, 1871.

Dr. Duvert[1] reports other cases, one of which was a confirmed drunkard. He could not stand, from sheer exhaustion. He remained in the bath twenty minutes, and after seven baths the case was cured.

Mr. S. Russell, Jr., of this city, has constructed a very useful galvanic bath, which may be seen in Fig. 54. It is claimed by the inventor that medical solutions may be introduced into the system by this arrangement. The currents can be localized by means of the perforated diaphragm therein. By the electrode E the current may be diffused. An external battery of several large Smee or Daniell cells furnishes the current.

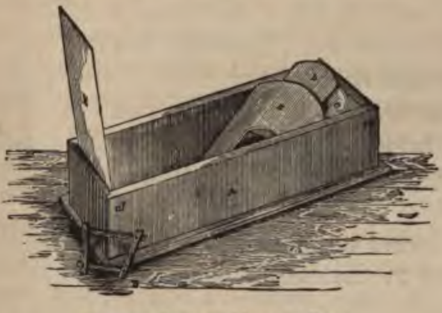

FIG. 54.—ELECTRO-MEDICAL BATH.

A, Tub.
B, Diaphragm.
C, Electrode.
D, Foot-rest.
E, Hinged Electrode.
F F, Binding-Screws.
b, Slide.

THE ABSORPTION OF INFLAMMATORY PRODUCTS.

Dr. Ludwig Seeger[2] gives several cases, where he produced absorption of inflammatory swellings by putting the positive pole on the plexus from which the affected part received its

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[1] *Memorabilien*, July, 1872.

[2] *Vienna Medical Presse.*

ELECTRICITY IN ORTHOPRAXY.

Drs. Lewis Sayre and Le Roy M. Yale have used it as an adjuvant to other remedies in many of the cases of talipes they have treated. Dr. Fisher, a distinguished specialist in orthopedics, whose position as a physician to the New York Orthopedic Dispensary enables him to see many cases of deformity, speaks most confidently of both galvanism and faradism, and has been kind enough to give the report of a striking case, which will convince the reader of the value of the electric treatment. In nearly all of the orthopedic diseases there is more or less paralysis and atrophy. In morbus coxarius, during the later stages, where there are resisting contraction of the muscles and anchylosis, galvanism may be suggested. In the atrophy of muscular tissue that exists, faradization will also give good results.

Dr. Fisher's case is as follows:

A. C., aged twelve and a half years, presented himself, on March 11, 1872, at the New York Orthopedic Dispensary, with paralysis of the right upper extremity. His father, who accompanied him, gave the following history of his case: He was healthy up to the age of seven months, when he was seized with fits of screaming at night, as if from great pain, without any ascertainable cause. During the day he appeared to be as well as usual. These attacks of crying continued nightly for about three weeks, and then his parents noticed that the right side of the body, including the face, was paralyzed. The inability remained complete for two months, after which an improvement began to show itself in the face and lower extremity, and continued to increase; so that, when he was about two years and a half old, the motility of both was entirely restored. But the right upper extremity remained completely useless, and became an encumbrance, as well as a source of considerable pain and distress. When the palsy was discovered, twelve years ago, the parents took the boy to Prof. Valentine Mott's clinique at the Medical Department of the New York University, and were there advised to resort to no treatment, but to keep the patient out of the hands of doctors. This counsel had been scrupulously adhered to up to the time of his application for treatment at the Orthopedic Dispensary.

On the examination, A. C. appeared to be a well-grown and fairly-nourished boy, though rather dull of intellect. There was no trace remaining of facial palsy, nor was there any difference noticeable between the two lower extremities, except that the right foot was a little smaller than the left. The right upper extremity was cold and lifeless, hanging helplessly by the side. It was two inches and a quarter shorter than the left, and the atrophy of bone and muscle was extreme. A marked difference between the two sides was apparent in the clavicle, scapula, and ribs, arising chiefly, no doubt, from the absence of that natural stimulus to growth which voluntary movement would have developed. A paralysis which had occurred during infancy, and existed for so many years without treatment, had of necessity resulted in deformity. The capsular ligament, and the tendons which reënforced it, had yielded to the steady traction of the weight of the limb, and the head of the humerus was dragged downward from the glenoid cavity, giving rise to considerable pain and discomfort. The hand presented the most serious deformities. At the wrist it turned strongly outward, so as to be at a right angle with the line of the bones of the forearm. The thumb hung semi-extended with marked atrophy of the thenar muscles. At the metacarpophalangeal articulations there were subluxations toward the palmar surface, so that in lieu of knuckles there were four deep dimples. The middle, ring, and little fingers, had undergone a partial rotation on their long axes and lay heaped up; the palmar surface of each resting on the dorsum of the one preceding it. The pectoral muscles and the deltoid could not be distinguished by manipulation. The muscles of the arm were entirely powerless, and so much atrophied that they could with difficulty be made out. The forearm was in nearly as bad a condition, but the patient had the power of moving slightly the middle, ring, and little fingers. There were no contractions produced by the faradic current in any of the muscles of the limb, but the trapezius, latissimus dorsi, levator anguli scapulæ, rhomboidei, and serratus magnus muscles, reacted distinctly to it. The galvanic nerve-muscle current, interrupted, produced contractions throughout the arm and forearm, but more markedly in the muscles of the latter than in those of the former. The deltoid and pectoral muscles were so much atrophied that the existence of contractile fibres could not be verified by the test of electricity, though the patient thought he could perceive a contraction in the latter when they were brought under the action of the galvanic current.

The electrical treatment of this case commenced with the use of the galvanic cord, plexus, and muscle currents interrupted, and in labile[1] applications down the arm. Improvement was immediate in the nutrition of the member, and, as a consequence, the numbness, pain, and other sensations of discomfort, which the patient had experienced for years, in varying severity, were considerably assuaged. Within the first week he was able to move slightly the forefinger, over which he had had no control for twelve years, and, at the beginning of the third week of the treatment, the muscles of the forearm reacted to the faradic current. After ten weeks of treatment the hair began to grow vigorously on the arm and shoulder, and the finger-nails required cutting more frequently than before. The duration of the applications of electricity was very brief, at first, in order that the feeble muscles might not be overtaxed.

Improvement has continued slowly and steadily, until, by degrees, all the muscles have come under the control of the faradic current. Galvanization has, therefore, given place to the latter in great measure, though it has been employed throughout for its stimulant effects upon the processes of nutrition and growth. There has been an average increase of one-third in the circumference of the limb, and now, after a year's treatment, instead of an utterly powerless arm, which dangled as an impediment by his side, the patient is able to pronate and supinate, to flex and extend the forearm, to swing the whole limb forward and backward, and to circumduct it with considerable force. He can carry the right hand to the left shoulder, and then elevate and depress the elbow, and, when the right hand is placed on his head, he can hold it there in position. There has been great improvement in the condition of the hand, although not yet sufficient to render it of much use. The thumb still remains beyond the control of the will, notwithstanding a very decided increase in the growth of its proper muscles. But the chief cause of inability lies in the character of the deformities of the fingers, which prevent the patient from using, to the greatest advantage, that muscular power which he has already gained. By the aid of a mechanical contrivance, the distorted joints are being slowly restored to their proper positions, and, as progress and growth in development are still advancing, there are strong hopes that, eventually, he will recover the use of quite a serviceable limb. During the year there have been two interruptions in treatment: one in April and May, of twenty-six days; the other in August, September, and October, of eighty-one days. There were seventy-two applications of electricity made during the remaining time—on an average of about twice a week. The boy's father was directed in the beginning to keep his son's arm well protected from cold, and to rub it vigorously twice a day at home, which directions were faithfully performed during the first three months. Frictions, kneadings, active and passive movements have been used as adjuvants to the treatment at the dispensary. Although these were of undoubted value in promoting the present degree of restitution of function, yet the main reliance in the treatment of this case has been placed in electricity.

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[1] *Stable* and *labile* are terms used to designate that both electrodes were held stationary, or that one or both are moved over the surface of the body.

Dr. Whittaker reports the following case of talipes:[1]

A. S., aged three, was brought to the clinic about June 1st. She is a hale, handsome child, which makes the deformity more than usually apparent. The talipes is of the valgus type, in the first stage, the flexors lacking tone, as also the triceps sural, for there is difficulty in lifting the foot from the ground. This gives a peculiarity to the gait, whereby the foot is dragged to the front with out-turned toes, somewhat as in the hemiplegic, but without the rotatory swing.

Treatment was commenced June 2d. No appliances of any kind were used, that the result might not be clouded by complications.

The application was exceedingly simple; the positive electrode, a disk of carbon covered with thick sheep-skin and moistened, was applied to the ham, and afterward to the inner aspect of the knee-joint, over the point designated by Morgan as the surface of application for galvanization of the internal portion of the gastrocnemius, soleus, and flexors of the toes, while the negative was stroked along the inner ankle and the inner border of the plantar surface of the foot. Galvanization (eighteen cups) was always continued until decided redness was manifest and sensation of burning was experienced. This usually occurred in about three minutes. Sessions were repeated regularly three times a week.

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[1] *The Clinic.*

At the end of three weeks the efficacy of treatment began to appear, less in relief of the deformity, than in the greater ease and alacrity of elevating the heel. At the end of four weeks deformity was only evident when the child was shod; in bare feet, there was no difference whatever in the two sides. In two more sessions (August 8th) there was no deformity whatever, and no difference perceptible in shoes.[1]

MISCELLANEOUS THERAPEUTICAL USES OF ELECTRICITY.

For the Detection of Metallic Bodies.—M. Favre, of Marseilles, has invented a little instrument for detecting the presence of bullets or other missiles in the human body. A probe is inserted into the wound, the extremity of which contains the ends of two wires from the battery. When this probe strikes the metallic body, the circuit is closed, and by an ingenious combination of hammer and magnet a bell is rung. By means of the magnet it is often possible to detect the presence of foreign bodies of a metallic character that may be embedded near the surface. An electro-magnet, with a very powerful current, will often remove a needle, even if it be located at some depth.

Carbuncles and *furuncles* may be dissipated in their early stages by applying to them the negative pole of the galvanic current, and the positive pole to some neighboring part.

Vomiting of Pregnancy.—Dr. S. Iffla presented a memoir to the Medical Association of Victoria (Australia), communicating the great value of electricity in cases of obstinate vomiting of pregnancy. In one remarkable case, defiant of all medication, where the patient was reduced to the last degree, prompt recovery followed the application of the constant current to the epigastric region. A recurrence of the same difficulty in the same case in a subsequent pregnancy as promptly yielded a second time to the same means.

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[1] In the application of galvanism, contractions may appear, and, after a while, cease. The cause for this is, that the muscular irritability is overpowered by too strong a current.

There are a great many other conditions for which electricity is recommended by various authors. I will simply say, in conclusion, that the study of electro-physiology, and the good judgment of the physician, will govern him in the treatment of those diseases I have not alluded to in this volume.

APPENDIX.

Management of Batteries.—Solutions for Batteries.—Insulation of Needles.—Galvano-Causty Apparatus, etc., etc.

MANY practitioners have been troubled in their management of electrical apparatus simply because they have not taken certain simple precautions which were necessary. It is important to keep all the connections of a battery free from the products of oxidation; to have the battery solutions fresh, and of requisite strength; to remove the plates from the battery solution after use, if possible, and to have all thumb-screws tight. The battery-cords, for the convenience of the operator, in most of the machines are colored red and green. The *green* cord is that to be affixed to the *negative pole*, and the *red* to the *positive*. This arrangement enables the practitioner to distinguish the pole without consulting the battery itself during the *séance*.

When the external coil of wire in the induction machine is drawn out, the force of the *primary* induced current is increased. When the polarity is changed by the apparatus for that purpose, pushing in the external coil (covering the bundle of wires) will increase the secondary current.[1]

BATTERY SOLUTIONS.

For Grenet's, Bunsen's, Stöhrer's, and the cups of the galvano-causty and Galvano-Faradic Company's batteries, the solution should be prepared as follows:

Potassa bichromate (pulverized)	℥ viij.
Cold water	Ov.
Sulphuric acid	℥ vij.

First dissolve the bichromate of potassa in the cold water, and, when *entirely dissolved*, add the sulphuric acid slowly.

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[1] Different instruments have various devices for accomplishing this.

If the cells are not readily removable from the batteries, a large hard-rubber syringe may be used for withdrawing the old battery-fluid and refilling with the new.

Solution for Smee's, Kidder's, and Curt Meyer's batteries:

Sulphuric acid	℥j.–℥iij.
Water	Oj.

M.

These should be cautiously mixed, as the heat produced by their sudden union is very apt to break the glass vessel in which they are contained.

For Hammond's modification of Hill's battery: Prepare a solution of sulphate of zinc, one pound and a quarter to each cell. Pour it in, filling the cell a little above the level of the upper surface of the zinc. Drop to the bottom, through the opening in the zinc, a few crystals of sulphate of copper. There is copper in the bottom of the cell immersed in a solution of sulphate of copper, forming a *blue* liquid. Zinc suspended above, immersed in a *white* liquid, a solution of sulphate of zinc. The darker part below represents the solution of copper; the lighter above, that of zinc.

Care of the Battery.—The *blue solution* should remain at the bottom, and *only there.* Therefore it must not be disturbed, or mixed with the other. Sulphate of copper is the nutriment of the battery, and is constantly being consumed. A few crystals require to be dropped in every two or three days. Keep the zinc clean. When its lower surface becomes incrusted, remove it carefully from the cell and scrape off the deposit. It will not require to be cleaned oftener than once in two or three months. As the zinc dissolves it loads the solution with sulphate of zinc, and in time this becomes *saturated.* Test it with the hydrometer. If it rises to 40°, remove about a teacupful of the fluid and replace it with fresh water. This can easily be effected by a battery-pump, a siphon, or a flexible tube. The water lost by evaporation must also be resupplied. Evaporation may to a great extent be prevented by pouring paraffine on the liquid, say to a depth of about half an inch. Remove the crystals that will form on the sides of the cell, above the surface of the liquid, by wetting the fingers with fresh water, and pushing them down. Above all, avoid mixing the two solutions.

In Smee's and other batteries, when sulphuric acid and water are used, it is well to put a teaspoonful of mercury into the cell; this keeps the plates amalgamated.

In all batteries, when carbon plates are used, it is well occasionally to remove and allow them to soak for several days in pure water, occasionally changing the same. The salts which collect in the substance of the porous carbon will, unless this is done, greatly interfere with the strength of the current.

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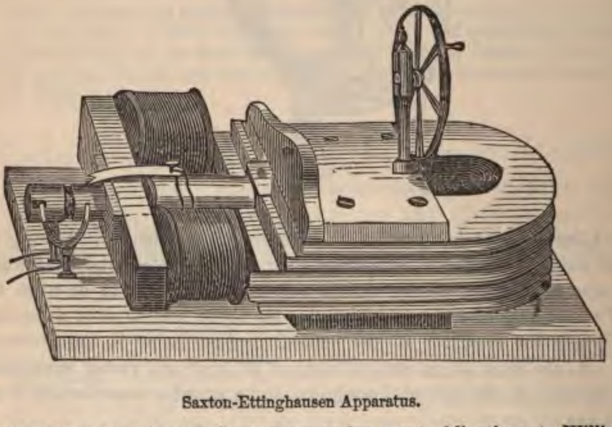

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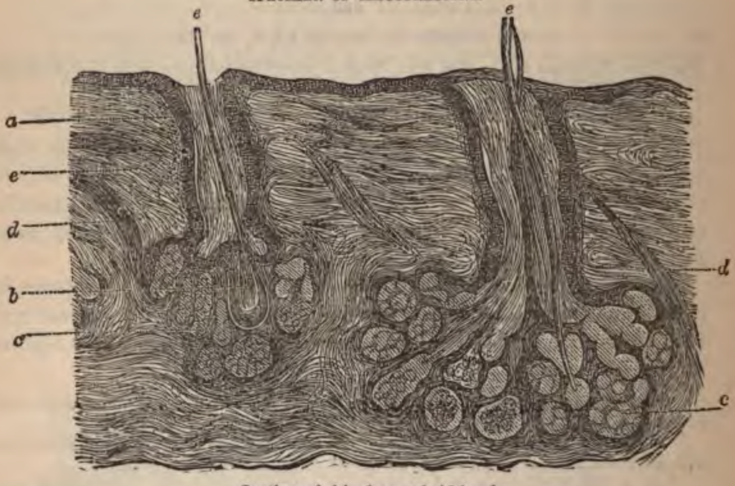

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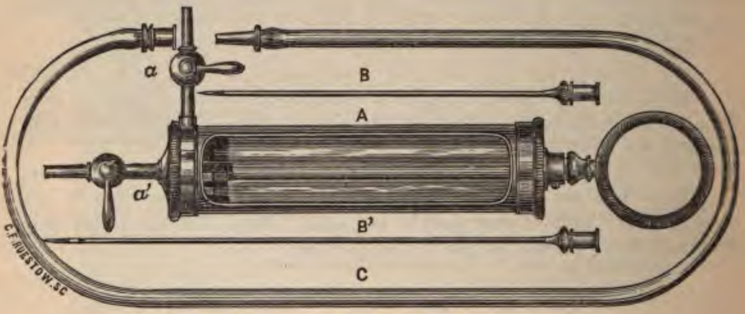

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